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THE
NATURE, PROPERTIES,
AND
LAWS of Motion of FIRE

Discovered and Demonstrated

BY

OBSERVATIONS and EXPERIMENTS.

By WILLIAM HILLARY, M. D.



LONDON:

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NATURAL HISTORY

AND

LAWS OF ALBANY

OF THE STATE OF NEW YORK

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OF THE YEAR 1807



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1797

TO THE
RIGHT HONOURABLE
THE
EARL of *MACCLESFIELD*,
PRESIDENT,

And to the
COUNCIL and FELLOWS
OF THE
ROYAL SOCIETY of *London*:

For the improving of *Natural Knowledge*,

This small Treatise on FIRE,

Is with all due Deference and Esteem,

Humbly Dedicated,

By

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THE
P R E F A C E.

SOME attempts to discover the subtle and mysterious nature of Fire by experiments, were first made above twenty years since; but the great difficulty of carefully examining such an untractable being, and sometimes the want of proper instruments for that purpose, and more frequently the avocations of my profession, often put a stop to my proceedings therein, and several times obliged me to lay them aside for several years. But the desire of obtaining a more satisfactory knowledge of its mysterious nature, as often induced me to renew my endeavours, whenever a suitable and more leisure time offered; till I discovered that Fire was a body, which did not move, and act by the same Laws of Motion, which all other material bodies do move and act by. This however did neither discourage, nor put a stop to my researches, when leisure permitted, but rather increased my desire to know, how, or by what Laws of Motion it did move and act, especially as it so frequently produced so many extraordinary, great and wonderful effects: And

still the more so, as it appeared probable, that a right knowledge of its Laws of Motion might be of great service, not only by inabling us to account more truly and satisfactorily for the production of several phænomena in nature, but also for the manner of the production of various diseases and their symptoms and effects, as also for some other extraordinary and wonderful effects which are sometimes produced by heat or fire; therefore was a thing of great importance, which is much wanted, and desired to be known.

And as I found that fire was a body of such an exceeding subtile and untractable a nature, that it only was, and could be known to us by the effects which it produces; therefore the only way to discover its mysterious nature and laws of motion, must be by the method of analysis, by experiments and induction from its effects to their causes, as it probably admits of no other method of being known to the human mind; and this, as it is so very subtile and untractable a being, was both very difficult and laborious.

But having thus by experiments, at last discovered most of its subtile properties, and laws of motion, I thought it the best method to reduce them into Propositions, and then endeavour to demonstrate them by the same experiments by which they were first discovered; as being the shortest and clearest method of communicating my sentiments on this mysterious and difficult subject to others.

And

And as a subject of this nature, was most proper to be sent to the Royal Society, I endeavoured to bring it into as small a compass as the repeating so many experiments as were necessary to demonstrate the truth of those propositions would admit of, without regarding the ornaments, or elegance of style: Nor will a thing of this nature, where the demonstration of propositions and experiments, wherein repetitions are often unavoidable, admit of it; as the intention is to express things clearly, intelligibly and truly; and not to study how to say things prettily, or wittily, to please some low critics, or ill-natured pedants; wherefore, I have not only disregarded the ornaments of style, but have avoided the use of geometrical figures and demonstrations, and have used as few mathematical calculations as the nature of the subject would admit of, to render it more intelligible to those, who may not be well acquainted with those sciences, and have omitted every thing, but what was necessary to prove the truth of the propositions, and demonstrate the properties and Laws of Motion of Fire, in order to bring it within the compass of a paper fit to be presented to that Honourable and Learned Society, without taking up too much of their time, or giving them too much trouble; Where I am told, it has met with a favourable reception.

But several persons desiring that it might be published alone, that those who do not take the
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Philosophical Transactions, might have it, I could not refuse complying with their request; wherefore I have made some few additions to the Introduction, and added a few Corollaries, to shew the necessity, and more extensive and general use of these Laws of Motion of Fire.

As the desire of discovering and knowing the truth of these laws, is what first engaged my attention to this subject; an impartial relation of facts is what I aim at in publishing them, that they may be more generally known: And if they can any way contribute any thing, either towards the further improvement of knowledge, and advancement of Science, or by any other way useful to mankind, I shall neither think my labour lost, nor my time ill spent.

East-Street, Red-Lion-Square,

Nov. 14, 1759.

INTRO-

INTRODUCTION.

SOME remarks and observations which I made several years since, on the nature of the production of *Heat* in animal bodies, and the many different degrees of it in various diseases; more particularly on the manner of its being generated and produced in fevers, gave the first rise to the following enquiries into the nature of *Fire*, its various degrees, and oftentimes secret and hidden manner of moving and acting. From these enquiries, and some experiments, it soon appeared that *Heat* in animals, and in all created beings, solely arises from *Fire*; and that even what the ancients so often mention, the *Oleum Empurion*, or *Callidum Innatum*, did solely proceed from it; and that the different degrees of heat in men, in all their different constitutions, are produced only by the various modes, and the different degrees of its acting. And that notwithstanding *Fire* is a being, which has been so frequently and familiarly used in all ages and nations, from the earliest account of time; its mysterious nature has been very little known, and still remains to be the least understood of all created material beings.

I was therefore induced to make some farther enquiries into the nature of this most subtle being: And in order to this, it was first necessary

sary to know what the ancient philosophers, and others, have said of it.

And as we find that *Fire* is so very extraordinary and powerful a thing, and so frequently produces so many great and wonderful effects, it was reasonable to expect a more clear and full account of its wonderful nature, than I have been able to meet with in any of the works of the ancients. But a few experiments soon discovered its properties to be so very mysterious and peculiar, that it is no wonder most of them have escaped the observation, and evaded the discovery of the best means and instruments of the greatest philosophers among the ancients. Some of these properties however were too extraordinary, and their effects too great, entirely to escape their attention and admiration; but as they found its power so great and extensive, its manner of acting so incomprehensible, and its effects so very wonderful, it caused various opinions among the greatest philosophers of different ages. Hence we find that some of the wisest eastern nations, and particularly the great Zaradusht, the Zoroaster of the Greeks, were induced to reverence it as a deity, or more probably, as the most lively emblem of the Deity. He probably knew as much, and has written more on the nature of *Fire*, almost 3700 years since, than any of the ancients either before or after him. But his Zend, or Bible, not having been translated out of the ancient Persee into any of the learned, or modern European languages, nor any thing of his, but a few extracts from it, by the learned Dr. Hyde and Dr. Pococke, we are unacquainted with his sentiments on the nature of fire further than what relates to his religion; from whence it appears that how much soever he might know of its myste-

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mysterious nature, his sentiments of it were very imperfect, if not absurd and idolatrous, since his followers the Perfecs or Guebers worship it as a deity to this day. We might have had a translation of his Zend, the most ancient book extant, if self-interested craft, or pious fraud, had not hindered it: Our not having it, is a loss to the learned, who would thereby have known what his sentiments on fire truly were; and probably those on a future state, and some other curious patriarchal opinions of the greatest antiquity, as he is supposed to have been cotemporary with Abraham. For truth neither is, nor need to be ashamed to appear any where, let it come from whence it will: And no man is obliged to embrace an error, or believe a falshood, at least in our free nation.

The next, after Zoroaster, that made any enquiries into the nature of *Fire*, are some of the ancient Greek philosophers, particularly Heraclitus; but we have nothing of his on this subject, except what Diogenes Laertius tells us; the sum of which is, that he found it to be so mysterious and powerful a being, that he thought it was the *cause* or producer of all other beings; which was in fact making it to be no less than Deity. Yet Plato (or his admirer and translator Marcilius Ficinus) appears to have known something more of its nature, as he tells us in his *Timeus*, that fire is so subtile that it pervades all other bodies, and is diffused through the whole universe; which is so far coming nearer to the truth of the matter, than any of his predecessors. And Hippocrates his cotemporary had the same sentiments of it. Hippoc. *de Vietus Ratione*, Lib. 1.

We meet with some others after him, who finding it to be so very mysterious, powerful, and subtile,

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tile, thought it to be an uncreated being, and ought to be esteemed and looked upon as a spirit, rather than a material body. From whence we may conclude, that they knew but very little of its nature; and still less of its properties; and nothing at all of its laws of motion.

And how so extraordinary and powerful a being, frequently producing such wonderful phenomena and effects, should thus escape the observations of learned and eminent philosophers, for so many ages past, is very strange. For whatever discoveries the ancients might make, all the accounts that are come down to our hands, are so short and imperfect, that they are altogether insufficient to give any tolerable idea of them, or what their sentiments on them were. It is most probable that they found fire to be so subtle and untractable, and its properties so difficult to be investigated, as either to have escaped their observations, or evaded all their enquiries.

Neither have any of the modern philosophers, (except the great Boerhaave) been more industrious, or successful in their investigations and discoveries. For it is certain, that of all the material bodies in nature which we are yet acquainted with, *Fire* is the least known; and *its singular laws of motion*, are at best much less understood than the *laws of motion* of all other material bodies.

It is certain, that the *laws of motion* of all other species of matter, were as much unknown to the ancients; neither were they discovered by any of the moderns, till the great Sir Isaac Newton, by his great penetration and surprising genius, investigated and discovered them. And if that great philosopher had enquired into the *subtile nature and laws of motion of Fire*, as he did into those of *light and colours*, and the *laws of motion* of all other bodies

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dies or matter, no doubt but we should have known as much of the first, as we do of the latter, and probably more than we can hope for now.

That ingenious chemist Homberg made some attempts, but not sufficiently observing the following rules, he had the misfortune to confound *Fire* with *Light*, taking them to be one and the same being, as some others have done before and since him, which has led them into great errors : But it will be here demonstrated that they are distinct beings.

Several others have made some attempts this way, without making any new discoveries, till the great Boerhaave, who wisely and judiciously pursued that excellent method of investigating the causes of things by experiments and induction, recommended by the great lord Verulam : As it is the most certain that the human mind can take, in abstruse and difficult things, in order to make such philosophical enquiries and discoveries ; and is such as will certainly lead us to the knowledge of all such unknown *truths*, if we are but sufficiently careful to direct our experiments right, and as careful not to admit any thing as a certain *truth*, but what is evidently observed, or clearly demonstrated to be so. And this is the method by which Newton, Boyle, Locke, and Boerhaave, and all other great philosophers since his lordship's time, have made discoveries ; a method which Sir Isaac Newton also recommends to others : “ As in mathematics, says he, so in natural philosophy, the investigation of difficult things by the method of analysis ought ever to precede the method of composition.---This analysis consists in making experiments and observations, and in drawing general conclusions from them by induction, and admitting of no objections against the con-

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“ clusions, but such as are taken from experiments,
 “ or other certain truths.---And although the ar-
 “ guing from experiments and observations by in-
 “ duction, be no demonstration of general conclu-
 “ sions ; yet it is the best way of arguing which
 “ the nature of things admits of, and may be
 “ looked upon as so much the stronger, by how
 “ much the induction is more general.---By this
 “ way of analysis we may proceed from motions
 “ to the forces producing them ; and in general,
 “ from effects to their causes, and from particular
 “ causes to more general ones. till the argument
 “ ends in the most general.---For hypotheses are
 “ not to be regarded in experimental philosophy.”

And thus Boerhaave with indefatigable industry and great penetration, judiciously enquired into, and made many curious observations and experiments upon *Fire*, by which he discovered much more of its mysterious nature, than all his predecessors had done before him. But although this *learned Professor* did thus discover most of *its subtile properties* ; yet *he* had not leisure to proceed so far as to discover *its laws of motion*, and to establish them as such, by demonstrating that *it* always moves and acts by them ; that was not his intention, but to discover the nature of *Fire*, and shew its use and application in a chemical way ; and so far he considered it in a philosophical, mechanical, and chemical light. See his *Elem. Chem.* Vol. I. *de Igne*,

This therefore induced me to attempt a discovery of *its laws of motion*, and to endeavour to establish them as such. And as *Fire*, though so frequently used, yet is a thing which is only known to us by the effects which it produces, how great and wonderful soever those may be ; it consequent-

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ly follows, that the only way by which we can obtain the knowledge of its nature and laws of motion, must be by the method of analysis, as it admits of no other method of being known to us, but by making careful observations and experiments, and drawing conclusions from its effects by induction to their immediate and particular causes; and again from their particular causes, to the more general ones, till we arrive at the most general, viz. *Its laws of motion*, as the great Newton advises. And as I formerly had the opportunity of seeing the learned Boerhaave make some experiments upon *Fire*, I have taken some of them from him, as also from other ingenious authors (whose instruments I could not have, nor procure such to be made) which I gratefully acknowledge, especially such of those experiments as were the most useful and applicable, and would contribute the most either to explain the mysterious properties, or to discover the subtile and hidden modes of motion of *Fire*: Some of which experiments I have repeated, and have also added several others which are new, more especially in the use and application of them, in order to discover *its laws of motion*.

But as I found in these enquiries and experiments, that most of the properties of *Fire*, and all its modes of moving and acting, were so different from, and some of them so contrary to the known *laws of motion* of all other matter, it often caused me to doubt their being true, which with the frequent avocations of my profession, and sometimes the want of proper instruments where I was, put a stop to my proceedings therein, and obliged me to lay them aside for several years. And seeing that the very name of *new laws of motion*, of any kind of matter, how true soever they might be, proba-

bly would be thought to be a sufficient reason for rejecting them, especially as we have been always taught that the laws of motion discovered by Sir Isaac Newton, are sufficient to account for the motions and actions of all material bodies; as they certainly are for the motions of all matter yet known, *Fire* only excepted, which has not been sufficiently enquired into, and will be here demonstrated to be a body which moves and acts by different *laws* peculiar to itself only: Notwithstanding these difficulties, often obliged me to lay aside my experiments for a considerable time; the desire of obtaining the knowledge of *its laws*, induced me to reassume them, whenever leisure offered, till I had obtained a more satisfactory knowledge of its properties, and singular modes of motion. And though they are so different from, and apparently contrary to the known laws of motion of all other matter; yet as repeated experiments demonstrated their truth; and as these actions of fire appeared to be general, and extended every where, even through infinite space, I could not reject them as being either erroneous or untrue, though they were so different from the laws of motion of all other matter: Since it is as possible that the *Divine Being* may have given different laws of motion to different *species* of matter, as to have created and given existence to different *kinds* of matter: And that *Light*, as well as *Fire*, are composed of different elements from those of all other kinds of matter, will appear from a more full and proper examination of their peculiar properties, tho' they are two different beings; and we cannot say that there is not almost as great a variety of species of matter existing in different parts of the universe, as there is a variety of other beings. However,
that

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that *Fire* is formed or composed of elements which are greatly different from the elementary particles of all other species of matter which we are yet acquainted with, will appear from the following peculiar properties and motions of *Fire*. First, *Fire* is a body without gravity; and in the place of gravity it has a peculiar tendency equally every way, as will be demonstrated hereafter: But all other bodies or matter gravitate towards the earth, or sun, &c. *Fire* is a body which easily penetrates and freely pervades all other bodies whatever, even the most dense and hard; which no other bodies can do (except light, which only penetrates and pervades all black and diaphanous bodies.) It also pervades and passes swiftly through the most dense and hard bodies, as through wires of gold and steel; which no other bodies can do. *Fire* is a body which is always attracted and collected by the motion and attrition of all other bodies. But all other material bodies are abraded, dissipated and dispersed by motion and attrition. *Fire* is a being whose constituent elements are in a constant and continual state of repulsion from each other, and the nearer they are brought to contact with each other, the more strongly they repel each other. But the nearer that all other bodies are brought to contact, the more strongly they attract each other, and the more firmly they cohere; air and fire only excepted. *Fire* is a being, which when it is collected into a given space in a great quantity, can dissipate and disperse, and restore itself by its own repulsive power, to a state of equilibrium and rest again, as it was before being thus collected; which no other species of matter can do. And lastly, *Fire* is a body which is put in motion, and caused to move with great velocity and act with force, by light emitted from

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from the sun. But no other bodies are caused to move by light ; for it is light that puts the fire in motion, and then the fire puts the elements of all other matter in motion.

That *Fire* is endowed with all these peculiar properties and singular motions and actions, I hope will be sufficiently demonstrated by the following propositions. And as it appears that many of them are so very different from the motions and actions of all other kinds of matter yet known, I think we may safely and justly conclude (especially as we know nothing of the nature or formation of matter, but from its effects) that fire is a being which is formed of elements, as different from the nature of the elements of all other species of matter, as all its modes of motion and action are different.

And as *Fire* is such an extraordinary and peculiar being, I have first endeavoured to demonstrate, by the following propositions and experiments, that it is a real body (though some have denied that) which may be collected into, and contained in a given space ; and can move from place to place, as matter or body in motion does, and therefore is a material body ; and can by such motions act with great power and force. And then I have endeavoured to demonstrate that it is a body which does not move and act according to the known laws of motion, by which all other bodies do move and act ; but that it always moves and acts by certain other *laws of motion*, which are peculiar to itself only, and not to any other species of matter that we are yet acquainted with. And then by an experimental enquiry into those its singular properties and modes of motion, I endeavoured to discover what they are, and how they act, so as to produce those extraordinary effects. And from those its peculiar pro-

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properties and modes of motion thus discovered and known, I was enabled to discover which of those modes of motion and action are truly and properly the *laws of motion of Fire*.

And inasmuch as these *laws of Fire* are so different from the laws of motion of all other matter, it was necessary to enquire by the same methods, whether they did any way interfere with, or hinder any other bodies from moving according to their own laws of motion, or not? And accordingly I soon found, that though these laws of fire are so different from the laws of motion of other matter, and are also so very extensive and powerful; yet as fire so easily penetrates and freely pervades all other bodies, it never either in its still state, or in its usual and common motions, either when put in motion by light, or by its own repulsive power, does interfere with, nor any way hinder any other bodies from moving and acting according to the direction of their own laws of motion, except in some particular cases, for a moment of time, where the quantity of fire is great, and its velocity and force violent, as in the action of lightening, the explosion of gunpowder, &c. where its force is so great as to exceed and overcome the laws of matter, and diverts and hinders other bodies from moving and acting according to their own laws for a few moments; but the instant that the action of fire ceases, or is passed over, their own laws of motion as instantly take place again, and they move and act according to them. Neither do the laws of motion of other matter interfere with, or any way hinder fire from moving and acting according to its own laws of motion, how different and contrary soever they are, or may appear to be. But I also found by those experiments, that the *laws of motion*

motion of Fire are so necessary to continue the existence and well-being of all other material bodies, that they could not so continue to exist without fire and its laws and actions. Wherefore I have added a few corollaries, in order to shew that the *laws of motion of Fire* are so absolutely necessary to continue the existence, and preserve the well-being of all created material beings both animate and inanimate, in that beautiful order, state and condition, in which they now exist, that they could not so continue to exist without them; neither could many other phænomena of nature be produced, nor could they and their effects be rationally and clearly accounted for by the *laws of motion of matter*, without the assistance of these *laws of Fire*. Because it is demonstrated, that if *Fire* did not move and act by, and according to its own laws in the manner hereafter explained, there could be no animal life, sensation, or motion, nor any animals in being; neither could there be any vegetable life, or vegetables for animals to subsist on, and be nourished with, without the assistance of fire, and its laws and manner of acting: Because without it and its power of acting, all matter, and all material beings, would be one immoveable, inactive, inert, solid cold mass at perfect rest.

And in order further to confirm the truth of these *laws of Fire*, I endeavoured to account for, and explain several of the principal phænomena of nature, wherein fire is concerned as a principal, or sole agent, and also for several of the extraordinary effects which it frequently produces, by and agreeably to those *its laws*, till I was fully satisfied, and clearly convinced by demonstration, that these laws which I have hereafter presumed to call the *laws of motion of Fire*, are really and truly the laws by which

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which it always moves and acts, and produces all its effects, and that as constantly and invariably as all other matter or bodies do move and act by their laws of motion. Wherefore I have reduced those its modes of motion and action into the following forms of propositions, or *laws*, that they may be more easily expressed, and clearly comprehended, and be more readily received and established as the *laws of motion of Fire*.

This method of proceeding by experiments, is generally both tedious, laborious, and expensive, yet is it the most certain and sure way to the knowledge of *truth*.

And having thus at last arrived at the knowledge of all or most part of the peculiar properties, and the singular laws of motion of this subtile and mysterious being; I have reduced them into *propositions*, and then endeavoured to demonstrate the truth of them, by some of those experiments by which they were first discovered, and then to confirm their truth again by more experiments and induction, as being the shortest, clearest, easiest, and best method of communicating my sentiments on this mysterious and difficult subject to others.

And lastly, As I had not leisure to pursue these speculations and experiments further, I have added a few *queries* in order to excite others, who may have more leisure, a better apparatus, or greater abilities, to pursue them, and make further discoveries in this, or in any other branches of the immense and unlimited field of nature, to the further improvement of knowledge, and the advancement of science.

How well I have succeeded in this task, I must leave to the candor of my readers; being sensible that with all the care and caution which I could possibly

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possibly use, so short and confined is the extent of the human mind, so infinitely extensive are the bounds of nature, and so subtle and untractable is this wonderful being called *Fire*, that some of its most mysterious properties may have escaped my best attention ; and if so, must be left to the discovery of future time.

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And having thus at last arrived at the knowledge of all or most part of the peculiar properties, and the singular laws of motion of this subtle and mysterious being ; I have reduced them into propositions, and then endeavored to demonstrate the truth of them by some of those experiments by which they were first discovered, and then to conduct them to the origin of the matter, and in this manner I have endeavored to communicate my sentiments on this mysterious and difficult subject to others.

And lastly, As I had not leisure to pursue these speculations and experiments further, I have added a few answers in order to satisfy others, who may have more leisure, a better apparatus, or greater abilities, to pursue them, and make further discoveries in this, or in any other branches of the immaterial and unlimited field of nature, to the further improvement of knowledge, and the advancement of science.

THAT well I have succeeded in this task, I must leave to the candor of my readers ; being sensible that with all the care and caution which I could possibly

T H E
NATURE, PROPERTIES, &c.
O F
F I R E.

THAT being which we call *Fire* is of such an extraordinary nature, and is endowed with such wonderful properties, and moves and acts by such singular and peculiar laws of motion, which are so very different from, and contrary to the well known laws of motion of all other species of matter that we are yet acquainted with; it is necessary to bespeak the candour of my readers, at least so far as to request them to suspend their judgment and censure, till they have read and duly considered the demonstrations of the following propositions: From which and the experiments, we hope it will appear that *Fire* is a body endowed with all the following subtile and mysterious properties, which are peculiar to itself only; and from those properties, thus known, we shall by the method of analysis from its effects to their causes, by other experiments and induction, be enabled to discover and demonstrate its true *laws of motion*. And it is hoped that no one will either oppose them solely because they are different from the laws of motion of all other matter, or reject them because they are new to them, since they are
laws

laws as ancient as fire itself, though they were unknown to us before.

As the discovery and knowledge of *truth* in this matter is what I aim at, I request no man's assent to the truth of any of them, any further than either the demonstrations, or the reason and fitness of the things, may inform and convince his judgment; and if I am mistaken in any point, I shall be willing to be set right; as I desire not to impose a mistake or error upon others for a truth: And no judicious man will reject them because they are uncommon or new.

Prop. I. *Fire is a being which exists in all places, or in every part of space in the whole universe.*

That *Fire* exists, though often unperceived by any of our senses, and in a considerable quantity too in every part of this terrestrial globe, even in the coldest subpolar regions which have been yet discovered, and which men have been able to endure, is evident from the following simple experiment, among several others: Nay, the greatest and hottest degree of fire may be instantly collected out of the coldest air, in the coldest regions, by the motion and attrition of one hard body against another.

The hottest and greatest degree of fire may be instantly collected in Greenland, Spitsbergen, Iceland, or in Tartary, solely by the collision and attrition of a piece of flint against a piece of steel, which in a moment burns and melts the abraded particles of the flint and steel into glass; and yet the greatest and hottest degree of fire which human art can make with the best fuel, will not burn such small abraded parts of flint and steel into glass in so short a space of time.

Let

Let that spark of fire so collected, be put to a great quantity of the best and driest fewel, in that cold place, and a prodigious great quantity of fire will soon be collected, and will burn with a prodigious great force.

Here all this great quantity of fire which was thus soon collected, existed in a still state of equilibrium in the circumambient cold air, and in the adjacent earth and ice in that cold place, at that time, the sun being then below the horizon, so that no fire could be emitted from it, or be collected from it then at that place. Neither was the fire new created, for poor impotent man can create nothing; but was only collected by the motion and attrition of the flint and the steel against each other; and was continually collected afterwards and increased by the motion and attrition of the constituent particles of the fewel and the elements of the fire upon and against each other, which so continued to act upon each other, till the elementary parts of the fewel were all consumed, and dissipated or carried off with the fire, as it returned into the air and earth again from whence it came, and was restored to its state of equilibrium and rest as it was before, where it would always remain at rest, if it was neither collected again by the motion of other bodies, nor put in motion by the directing power of light from the sun, as will be demonstrated hereafter. Prop. III. IV. and Law I. II.

The greatest degree of cold that ever was observed in Iceland by Fahrenheit's mercurial thermometer, reduced the mercury in it as low as No. 0, in which cold one would suspect that there was very little or no fire existing; yet the same ingenious artist did by a mixture of *salts, ice, and spirit of nitre*, produce a degree of coldness in Holland greater by 40 degrees; but what is still more surprising

prizing and almost incredible, Dr. J. G. Gmelin, in his Preface to his *Flora Sibirica*, tells us, that he found the mercury in De Lisle's thermometer at Kirenginski in Siberia, to fall as low as 280, which is equal to 120 degrees below 0 in Fahrenheit's thermometer, which is 80 degrees colder than that artificial cold made in Holland, and 120 colder than in Iceland (if there is no mistake either in the observation or calculation) which is the greatest degree of cold ever yet known: And yet we cannot assert that no fire existed in that greatest degree of cold yet known at Kirenginski; for if the same experiment had been made there with *Spirit of Nitre*, as was in Holland, it probably would have caused the Mercury to descend 40 degrees lower still; or, if art should encrease that coldness still farther, it would be a proof, that fire did exist in that 120 degrees of cold greater than 0; and as both people, and some other animals lived there; no doubt, but some fire still existed in that cold air and earth, as they had fires there. And seeing that so great a degree of fire may be so instantly collected, in the coldest places yet known in this terrestrial globe; may we not conclude, that if there are any places, which are several degrees still colder than it, that fire may probably be collected in those colder places in the same manner.

And inasmuch as Fire thus exists in the coldest places on this earth, may we not conclude, that it is extended throughout the whole solar system, if not through infinite space. This last hypothesis, (for so I must call it) seems to be very probable, when we consider, that the elements of fire are in a constant state of repulsion from each other, till restored to a state of equilibrium and rest, as will be demonstrated hereafter. Law II.

Fire

of FIRE.

Fire does not only thus exist in every part of space, but it is equally diffused in and through all other bodies whatever; through the most solid dense and hard, as well as through the most light and rare, in an equal manner, unless this distribution is hindered, or changed, by the directing power of light from the sun, or by the motion of other bodies; as will be proved hereafter, Law I. and II. For, if we place the most accurate thermometer in the filings of iron, gold, or marble, or in whatever body you place it, it will shew the same degree of heat or coldness, as it will when it is placed in silk, cotton, feathers, wool, water, rectified spirit of wine or air, provided that they are all first equally exposed openly in the air for a sufficient time: Which shews that Fire equally pervades all bodies alike, through infinite space, if not hindered by the above-mentioned causes.

Yet it is most probable that *Fire* is not able to penetrate and insinuate itself into the ultimate impenetrable elements of bodies, but is repelled by them, when it exerts its force upon them; and the more so, the greater the force is, by which it endeavours to penetrate them: Hence, some degree of attrition must arise between fire and other bodies; but fire itself does not in reality penetrate and reside in the proper substance of bodies, but only in the small vacuities left between their ultimate elementary particles. Hence we must conclude, the *ἀδιάπεκτος*, or impenetrability of *Democritus* is proper to *Fire*, as well as to all other bodies; as the great *Boerhaave* observes, *El. Chem.*

Prop. II. *Pure Fire is a real body, and consists of the most simple, solid, hard, smooth, and smallest elementary particles of all matter yet unknown.*

Notwithstanding, that *Fire* is such an exceeding subtle being; yet when it is inquired into, in a suitable and proper manner, it may be rendered so perceptible and evident to several of our senses, that it may be demonstrated to be a real corporeal substance, or body.

First; *Fire* is something that is extended, and fills some space, and may be moved from place to place; and consequently may be measured by geometrical lines; and can act upon all other bodies with great power and force, and move with great velocity, &c. all which give us a true idea of what is called body; as the following experiments will more fully prove.

Collect this *pure Fire* with a glass globe, or an electrical machine, into a receiver, which is well lined or coated with a metallic substance, as in the usual manner in such experiments; and let a wire of any metal be extended from near that receiver, to as great a distance as you please, then let another wire be returned from near the end of the first wire, and so place as many wires to pass forwards and back again, as you please; let these wires be so placed that their ends may not touch, but come as near to each other as the $\frac{1}{8}$ of an inch. Then bring the end of the first wire by the means of the machine, as usual, in this experiment, to touch the receiver; and the fire which is collected in it, will instantly pass along through all the wires with great velocity, and will jump over the ends from one wire to another, and so on to and through all the wires; and as it passes or jumps over from one wire to another, it will give a visible flash of fire, and at the same time make an audible noise, or snap: And if the wire is touched with the finger of a person not electrified, or who has a less proportion of fire in his

of FIRE. 7

his body, the fire will pass from the wire into his body, and give him a smart stroke or shock; so that he will both see, hear, and feel the fire act upon his body or senses, as matter or body in motion acts upon us.

By this experiment, it evidently appears, that fire is a real body, which was collected in a considerable great quantity into a certain given or circumscribed space, which space it quitted and passed on into another space, and so successively on to many other places, as matter or body in motion does; and consequently must be a real substance: And that it is truly corporeal, is evident to no less than three of our senses, (though this has been denied by some persons, who at the same time have readily acquiesced in knowing that many other things are, which only are perceived by one of our senses :) But this fire, whilst it is thus in motion, may be clearly seen, distinctly heard, and sensibly felt, therefore it must be something that is really corporeal, and acts on our senses and bodies as matter or body acts.

Fire is not only thus demonstrated to be a body; but we shall make it appear to be a body composed of the most simple, solid, hard, smooth, and the smallest elementary particles of all matter: For if the ultimate elements of fire were not such as above described, they could not so easily penetrate, pervade, and so freely and quickly pass through the solid substance of those wires, as we see it does.

Let us suppose the wires in this experiment to be made of gold, which is the most solid and dense of all metals, and consequently has the smallest pores; and the fire will be found to pass through them with the same ease, and with the same inconceivable velocity, as it did through the iron or brass wires.

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If it be objected, that the fire does not pass through the body or substance of the wires, but on its surface only; the contrary is demonstrated by covering the wire with wax, (which is a substance, through which fire will not easily pass, as it is a viscid pabulum of fire.) And the fire will pass as freely and swiftly through the wire, as it did before the wax was put on; therefore it must pass through the body of the wire.

Take a globe of solid gold, or a diamond, the heaviest and hardiest of all bodies, place them in a strong fire till they are red-hot; then take them out of the fire, and divide them into two hemispheres, and you will find that the fire is equally distributed into every part or point, and between every ultimate elementary particle of them. Let them cool, either when divided, (or without dividing them,) and the fire will escape out of them by its *repulsive power*, without altering them, or changing their form in any respect, and will itself remain to be immutably the same fire, though it was so intimately mixed and dispersed between every elementary particles of those bodies, but a little before.

In these experiments, if the particles of the *Fire*, were not exceeding *small*; nay, considerably smaller than the particles of the gold, or the diamond, which are the densest and hardest of all bodies known; they could not so easily pass into, and again out of those bodies, without changing their form; yet we see that they actually do so; consequently the particles of fire must be exceeding small, or the smallest known.

Again, if the particles of the *Fire*, were not the most *Simple*, that is, if every single elementary particle of *Fire*, was not of the same nature, matter, and form with the whole, they would be unequal,

equal, harder in one part than in another, or irregular in their form; and consequently must meet with a resistance from the small pores of the gold or diamond, which pores must be exceeding small, as they are such dense or hard bodies; consequently the particles of the *Fire* could not pass through those very small pores with so much ease, and with so great a velocity, as we see they do, if they were not exceeding *simple*, as well as exceeding *small*.

Neither could the particles of *Fire* pass through such dense solid bodies, unless they were perfectly *smooth* also. For if their surfaces were unequal, rough, pointed, or hamated, those higher parts, points, or hooks, must strike against the sides of those minute pores of such solid bodies, and be retarded or stopped in their motion, which is contrary to fact: Or if they were pointed or hamated, those points, or hooks, and higher parts, must be abraded and broken off, and consequently the elements of fire must be changed, and fire itself must undergo perpetual alterations, and have its nature changed, and must at last itself be destroyed, which is contrary to all observation and fact. Wherefore we may justly conclude, that the elementary particles of *Fire*, are not only perfectly smooth and polished, but that they are also perfect *Spheres*, because that figure is the least ~~mutabile~~, the most solid and durable, and every way the fittest for quick motion, as well as the fittest and most capable of penetrating and pervading all other bodies.

Lastly, these ultimate elements of *Fire*, are probably the most solid of all bodies. By a solid, I mean, that extended substance or being, which makes an infinite resistance to all other bodies: And by space, that extension which admits and

transmits bodies. An absolute solid is such an extended being, as in which there is not the least penetrable space; but which is through its whole extension, and in every geometrical point of it, perfectly impenetrable. A body composed of particles thus perfectly solid, but so united together, that there are the least spaces conceivable left between them, is a dense body, but is an extended being, which is partly body, and partly space. Hence it is evident, that the smallest elements of all bodies, must be the most solid: For in these ultimate elements, it is probable that there are no pores, hence they are perfectly solid, and consequently not to be divided by any other bodies, but remain immutably the same.

That *Fire* is such a body, which is composed of those smallest simplest, smoothest, hardest, and the most solid elementary particles, appears from its so easily penetrating, and so quickly pervading all other bodies whatever, and still remaining immutably the same being.

Fire then, according to this doctrine, must be totally corporeal, immutable, and incapable of having its figure or form changed, or being destroyed: And is neither liable to any adhesion or concretion with itself, nor with any other bodies. See *Law II.* And yet it is most wonderfully endowed with, and has a singular and subtile power of penetrating, and minutely dividing the ultimate elementary particles of all other bodies whatever, that we are yet acquainted with. See *Prop. IV.*

Prop. III. Pure Fire is one and the same being in all places. Or there is but one species of Fire existing in nature.

That *pure Fire* unmixed with any other body or matter whatever, may exist alone in a very
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of FIRE:

considerable quantity in a given space, without being perceived by any of our senses, appears from what is said before, p. 4, 5. And yet it may be collected in that same space, and at the same time, various ways by several instruments, and then it will not only become the object of several of our senses, but it will produce various Phænomena, and many different and wonderful effects, accordingly as it is either put in motion, or as it is mixed with, or made to act upon various other bodies.

But when, or wherever *Fire* is collected in a sufficient quantity, by any art, by any method, by any instrument, or by whatever way or means it is collected or produced, it will upon a strict examination be found to be one and the same immutable being. Collect *Fire* from the rays of the Sun with a catoptrical speculum, or a dioptrical lens; or by the collition and attrition of two hard bodies, as a flint against a piece of steel; or by the friction and attrition of one plate of iron against another, as hereafter described, *Law I.* or by the friction of a hard piece of wood against a softer piece, as the Indians usually get fire; or by the motion and friction of a glass globe against a soft cushion, as in electrical experiments; or by lightening from the clouds when it strikes bodies and sets them on fire; or by the motion of wheels, mills, or engines; or by mixing different chemical preparations together; or by the fermenting of vegetable substances; or from a candle or culinary fire; or which way soever the fire is collected or obtained; if it is applied in the same quantity to the same body, it will always produce the very same phenomena and effects. Collect *Fire* all these different ways, and apply the same quantity of each, to the same quantity

quantity of any pabulum of fire, viz. to the same quantity of rectified spirit of wine, and you will find that the same pure white flame will be produced in each exactly alike, and they will all continue burning alike, till the spirit in each is all consumed, and then the *Fire* will dissipate and disperse itself from each, by its repulsive power. *Law II.* equally into the common mass of *Fire* again, from whence it was collected.

Let *Fire* be collected all these ways, and apply the same quantity of each to so many quantities of sulphur, camphire, oil, gunpowder, wood, coal, or to any other pabulum of fire, and each and all will produce the same phenomena and effects; and when they are all consumed, the *Fire* will invisibly return to, and mix again with the one homogenous mass of *Fire* from which it came, and will exist with it in a still state, till it is put in motion again, either by the motion of other bodies, or by the directing power of the sun. Therefore *Fire*, however it is collected or obtained, is in all places, and at all times, one and the same immutable being. And this being unmixed with any other body whatever, I here call *pure Fire*.

When *pure Fire* is applied to, and mixed with different sorts of pabulum, or different kinds of matter, and its elements are acting upon the constituent particles of those different bodies, it must produce different appearances, and various effects: But those different appearances and effects, arise solely from the different natures of those different bodies to which it is so joined. And when this *pure Fire* has consumed and dissipated those bodies, it separates itself from their remains, and restores itself by its repulsive power, *Law II.* to its state of rest, and ceases to act, and is the same that it was before it was joined to those bodies, and will

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ever continue to be the same immutable being in all places, and at all times.

Prop. IV. *Pure elementary Fire penetrates, pervades, rarifies and expands all other bodies in the universe, both solid and fluid, which fall under the observation of our senses. And this power is peculiar to Fire only, and to no other body that we yet know.*

That *Fire* is endowed with these extraordinary and most wonderful properties, and this singular power, is demonstrated by the following experiments.

Air, which is the thinnest and lightest of all bodies (except fire and light) is every way pervaded, expanded, and rarified in all its parts, by the addition of *Fire* to it, as will appear if we take an air thermometer made after the manner of Drebbelius, and apply the smallest degree of heat or fire to it, only breathe upon it, and the air contained in its flattened spheroidal globe will expand, and press down the fluid which is contained in its neck.

Rectified spirit of wine is the next lightest fluid; take a thermometer made with it in the common manner, and apply the smallest degree of heat or fire to the globe of it, even the warmth of one's hand, and the spirit contained in it is soon rarified and expanded, and rises in the neck of the thermometer. In the same manner is water, and every other fluid that we know, rarified and expanded by the addition of heat, which is the property and effect of fire: Even quicksilver which is the densest and heaviest of all fluids, is easily pervaded, rarified, and expanded, by the addition of fire: Thermometers made with this fluid plainly demonstrate this.

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In like manner all solid bodies whatever, even the most dense, heavy and hard, are pervaded, rarified, and expanded by fire.

Take a small solid bar of iron three feet long, let it be exactly fitted to go into a cavity made in another bar of the same metal, which is something longer than the first, and let that longer end be graduated into the tenths of an inch. Then place the first bar opposite to the sun till it is very warm, the other bar remaining in a cold place; then put the warm bar into the cavity of the other bar, and you will find it so much extended longer, that it will not go into the cavity into which it easily went before. Then ignite the first bar red-hot, and place it again upon the cavity of the other bar, it being still cold, and the first bar will be found to be near $\frac{5}{16}$, or half an inch longer than it was when it was cold.

This extension of the iron is solely made by the body of the fire insinuating itself into the vacuities between the constituent elementary particles of the iron, and so rarifying, dilating and expanding them further from each other, than they were before, whereby it encreases the bulk of the iron, and makes it fill a greater space than it did before; for it is evident that no other body but fire is here added to the iron: Let the heated bar rest till the fire is escaped out of it (as it will by its repulsive power, as at Law II. hereafter explained) till the bar is become as cold as it was at the first, and it will then go into and exactly fit the cavity as it did before.

The truth of this is also confirmed by the observations which have been made on the famous long iron gallery at Venice, which in very cold weather is always found to be considerably too short for the place for which it was fitted and made; but in the hot season of the year, when the sun has heated it
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several hours till it is very warm, it then exactly fills and fits the place by being expanded by the heat.

Take a sphere of gold, which is the densest and heaviest of all metals, make it exactly to fit and pass through an iron ring; then ignite the sphere till it is red-hot and ready to melt, then place it upon the ring, and it will not go into nor pass through it: Let the sphere remain till it is cold, and it will then pass through the ring as easily as it did before.

The same rarification and expansion by *Fire* is made and found in all other bodies whatever, whether solid or fluid, in the lightest as well as in the heaviest, and most dense and hard, that we know. See *Prop. I.*

Hence it is evident that *Fire* is a being which is possessed of this most extraordinary and wonderful power of penetrating, pervading, rarifying, and expanding all other bodies whatever, both solid and fluid, that we know. And there is no other body or being in nature which we are yet acquainted with but *Fire* only, that is endowed with, or that has this power of thus acting upon all other matter.

This rarification and expansion of all other bodies, is then a certain and sure indication of fire being present in any given space: And by them we may certainly know that fire exists, and is present either in a greater or less degree in any given space. And a thermometer made of spirit of wine, or of mercury, or a pyrometer made of iron or some other metal, are the most proper and most certain measures of the quantity of fire that exists, or is contained in any given space, or in any body.

Prop. V.

Prop.

Prop. V. *Pure Fire is a body without gravity; and has no more tendency to any one part of space, than it has to any other.*

As we have always been accustomed to connect the idea of gravity with that of matter or body, and to make weight one of the general and essential properties of body, we are very unwilling to separate them: Hence this surprizing property of fire, which is so directly contrary to the well known law of gravitation, which we always observe in, or find to be superadded and connected to all other species of matter that we yet know, may probably be thought a sufficient reason for not admitting this as a real fact; nay, some have positively denied it to be true; but that was too hasty a presumption: Since it is certain that it is equally as possible for the Deity to create one species of matter without gravity, as to create another with it, or to superadd gravity to the other species of matter. And as we find from several of the preceding experiments, that *Fire* is a body which is endowed with several other peculiar and extraordinary properties, which no other species of matter that we are yet acquainted with, are endowed with, let us first duly consider and examine the following experiments, before we deny the truth of this.

A pretty large thin glass receiver, containing near four gallons, which was well coated or lined on its inside with very thin metal (as made use of in electric experiments) was placed in the scale of an exact balance, and it exactly weighed eight pounds: The receiver was then charged or filled with *pure Fire* by an electric machine; and when it was full charged, and contained as much fire as could be gotten into it that way, it weighed exactly

ly the same weight, and no more: The fire was then discharged from it in the usual manner, and was so great a quantity as to strike a chicken dead in a moment: And when all the fire was thus discharged and gone out of the receiver, so that it contained no more fire than was in an equal space in the circumambient air, it weighed exactly the same weight as it did when it was full charged, and as it did before it was charged, and neither more nor less. Hence it evidently appears that this *pure Fire* has no gravity or weight.

A very thin large glass decanter, with a moderate small neck, was filled with boiling hot water, then placed in a pan full of hot water over the fire, so that the water in the decanter might take in as much *Fire* as it could contain, viz. till it boiled, the decanter was then close stopped with a well ground glass stopper, that no water might evaporate out of it, then it was taken out of the pan and wiped perfectly dry on its outside, and placed in the scale of an exact balance, and it weighed exactly $\text{lbiii. } \frac{3}{4}\text{xiii}$. It was then let stand in the scale till it was as cold as the circumambient air, and it then weighed exactly the same weight as it did before, when it was filled with as much fire as it could contain. Because water can be made no hotter than boiling hot, for if it boil ever so long, or ever so fiercely, it will be no hotter, because it then continually emits as much fire in the ebullition, as it admits or takes into itself from the fire, therefore it cannot be made hotter.

In this experiment, so much fire was taken into, and intimately mixed with the boiling water, as expanded its body and encreased its moles three cubic inches, yet it was no heavier: And when it had stood till so much of its contained fire was escaped out of it, as rendered it as cold as the circum-

cumambient air, it weighed exactly the same weight as it did when it was hot.

Here such a quantity of the body of fire was added to the water, as encreased its moles three cubic inches, yet it did not in the least encrease its weight; consequently this body of fire had no gravity.

A hollow sphere of iron, well polished on its outside, that it might lose nothing of its weight in the fire; because iron so polished will bear being made red-hot in a strong fire, without losing any thing of its weight, was first put into the scale of an exact balance, accurately made to move easily with the smallest weight; and it weighed exactly $\text{lbvi. } \frac{3}{4}$. The globe was then ignited till every part of it was perfectly red-hot; it was then taken out of the fire, and all the dust clean shaken and blown off it, and put into the scale again, and it was found to be exactly the same weight as it was when cold, the balance of the scale remaining at rest: It was then left in the scale till it was as cold as the circumambient air, and it then weighed exactly the same weight when it was cold, as it did when it was red-hot. The diameter of this sphere when cold was five inches, and its diameter when it was red-hot was $5 \frac{1}{8}$ inches; and it being a sphere, it consequently was encreased in its moles 2.551 cubic inches. Now this encrease in its moles was solely from the addition of the particles of the body of the fire, and from no other cause, as nothing but pure fire was added to it, yet it was no heavier.

Moreover these particles of fire were greatly compressed and condensed, by the strong attraction of the particles of the iron towards each other, whilst the particles of the fire equally and forcibly insinuated themselves between each elementary particle

ticle of the iron, and dilated it; consequently a greater quantity of fire must be contained in the iron, as it was so much compressed and condensed whilst it remained there. And yet notwithstanding that the sphere was so much encreased in its bulk by the addition of that body of fire, it was not the least encreased in its weight; wherefore we must conclude that *Fire* is a body which has no *gravity*.

The great professor Boerhaave made the same experiment with a piece of the best iron, whose weight was five pounds eight ounces, and its form a parallelipiped; and he found that it was not the least heavier when it was red-hot, than it was when it was cold, though it was considerably encreased in its bulk by the fire.

In all these experiments, though carefully made, there was a considerable quantity of real matter collected and added to each of the bodies above-mentioned, which matter was *pure Fire* only; and tho' it did very considerably encrease the bulk of each of them, yet it did not in the least encrease the weight of any of them; consequently it evidently appears that *Fire* is a body without *gravity*.

It is not only thus demonstrated that *pure Fire* is a body which has no *gravitation* either towards the centre of the earth, or towards the *sun* as the centre of the solar system; but that it is a body which has no greater disposition or tendency, either by attraction, or repulsion, or from any other cause, more towards any one part of infinite space, than it has towards any other part of space (except that as it is attracted by all bodies in motion, and repelled by light from the sun, as will be demonstrated hereafter, *Law I. III.*) may be demonstrated by several experiments, some of which will be mentioned hereafter, but I shall only make use of the following experiment here, as being sufficient.

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Take a sphere of brass or iron, of a foot diameter, or of what magnitude you please; ignite it in a large fire till it is red-hot in every part of it, then suspend it by a chain in the air; and the *Fire* which it contains will by its *repulsive power*, *Law II.* pass out of it, in equal quantities, from every point of its surface, in diverging right-lines from its centre, from every side of it. For if you place four or more thermometers, which are made to move easily with a little heat, and so graduated as all to rise to the same degrees of heat, when the same degree of fire is applied to them; place one above, another below, and one on each side of the suspended sphere, at equal distances from it, and you will find that the spirits or mercury in each thermometer, will receive the same quantity of fire or heat, and they will all rise exactly to the same height in the necks of all the thermometers. This evidently shews that the same quantity of fire is equally emitted from each point, and each side of the sphere, every way alike; and that the fire has no greater direction or tendency, either upwards, downwards, horizontally, or obliquely, nor any one way more than another; neither towards the centre of the earth, nor yet towards the sun, either by the law of attraction or gravitation, neither towards any one particular point or part of infinite space, more than it has towards any other part of it; and that till all the fire which the sphere contained in it, more than was in an equal space in the circumambient air in which it was suspended, was emitted out of it, viz. till the fire in the sphere, and that in the circumambient air, were restored to a state of equilibrium and rest; as will be more fully explained and demonstrated hereafter.

Hence it evidently appears that *Fire* is a body which has no attraction to, no repulsion from, nor any

any direction or tendency towards any one body, or to any one given space, more than it has towards any other part of space, when it is not acted upon, or put into motion by the action of some other bodies upon it. But that it is put into motion and is attracted and collected by the motion of all other bodies, as by *Law I.* and that it is repelled or put in motion by light from the sun, *Law III.* and by its own repulsive power, *Law II.* will be fully demonstrated when we come to speak of those laws, p. 30, &c.

Prop. VI. Pure Fire exists in a state of equilibrium and rest in every part of space, till that state is changed by the motion of other bodies, or by the directing power of the sun: And those ceasing to act on it, it restores itself by its repulsive power, to the state of equilibrium and rest again.

That *pure Fire* is a being which exists in every part of space, though it may not be perceived by any of our senses at the same time, because it exists in a still state, is sufficiently demonstrated before, *Prop. I.* And that it exists in a still state of equilibrium and rest in every part of space, till it is acted upon and put into motion, either by the motion and attrition of other bodies, or by the directing power of light from the sun, will appear from the following experiments.

Take a thick solid plate of iron, fix it in a cold place in the coldest frost, where no fire is perceptible to any of our senses; then lay another plate of the same metal upon that, and let them be pressed hard together by a great weight laid upon them both; then let the upper plate be rubbed with a strong and very quick motion, and in a little time they will begin to grow warm, and then hot, and

if the motion of the plate is continued with the same velocity, both the plates will in a little time acquire such a degree of heat as to emit sparks of fire, and at last the whole mass of both the plates will be as red-hot as if they came out of a large fire.

Here the *Fire* was at the first equally distributed in a still state of equilibrium and rest, both in the plates and in the circumambient air and adjacent earth and other bodies, in so equal a manner, that there was not any more fire in any one place or body than in another, not even in the iron plates themselves before they began to move; nor was any fire perceived by any of our senses; but as the plates began to move, the equilibrium of the fire was soon changed, and a much greater quantity of fire was soon collected into the plates, solely by their motion and attrition, than there was in them or in the circumambient air or adjacent places in the same given space before: And all that fire was collected solely by the motion and attrition of the two bodies of the iron. Then let those two hot plates remain at rest a sufficient time, and the fire which was thus collected in so great a quantity into them, will continue gradually to escape out of the plates, by Law II. in right-lines, and will so equally diffuse and distribute itself through the circumambient air and adjacent bodies and places again, that there will not be more *Fire* or heat found by the most accurate thermometer in any one place near where the experiment is made, than there is in any other place, not even in the iron plates themselves.

From this experiment it plainly appears, that the *Fire* was equally diffused and distributed through every space or place near to where the experiment was made, and that in a perfect equal manner, and was in a still state of equilibrium and rest in respect to

to itself, till it was collected by the motion and attrition of the iron plates, though it was but in a very small quantity, as the experiment was made in a cold place, and where no fire was perceptible to any of our senses. Also that the motion and attrition of the iron plates soon changed that state of equilibrium of the *Fire*, by collecting it to them : But that motion ceasing, the law of attraction of *Fire* by motion, *Law I.* instantly ceased to act also, and no more *Fire* was collected : And that motion ceasing, the *Fire* was as soon dissipated and dispersed by its repulsive power (which is another law of motion of *Fire*, *Law II.* and may be called the antagonist to *Law I.*) and soon restored itself thereby to its natural state of equilibrium and rest again. And most probably would, as its elements are immutable, for ever continue in that state of rest, if all other bodies ceased to move and remained in a state of perfect rest ; and the sun also ceased to act on the *Fire* to put it into motion, as will be more fully explained by the following experiments. But all bodies never cease to act at the same time, nor does the *Sun* ever cease to act on the *Fire* in all places at the same time ; therefore the whole mass of *Fire* is never all at perfect rest in all places at the same time.

Collect the rays of the sun with a large concave speculum, as that of Viller's, into its focus, and there you will have the greatest and hottest degree of *Fire* that human art has yet been able to produce : Instantly cover the face of the speculum with a white cloth, and all that prodigious great quantity of *Fire* which was so collected, and existed in that focus but the moment before, will instantly disperse itself, and soon be equally diffused through the circumambient air, earth, and other bodies again, and that so equally, that the most

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accurate thermometer will shew that there is not any more fire or heat in any one place near, not even where the focus was but the moment before, than there is in any other place near it, or than there was in that place before the experiment was made.

Here again the *Fire* existed in a still state of equilibrium and rest, till the sun put its elementary particles in motion in parallel right-lines, and then they were received upon the speculum, and reflected back into its focus, where they burned and consumed all other bodies that were put there: But the moment that the face of the speculum was covered, the fire ceased to act or burn in its focus. Or let us place the face of the speculum from the sun, so that no rays of light can come directly from the sun upon it, then the speculum will neither collect, nor reflect any *Fire* into its focus; though as much *Fire* really exists in the circumambient air, as there did before, when the speculum was turned to the sun, as appeared by a thermometer placed in that room, at that time; consequently it is the sun, and it only, which has the power of putting the pre-existing *Fire* into motion in parallel right-lines, and causing it to act with great power and force; and the speculum only has the power of collecting and reflecting the *Fire* when it is put in motion. And the moment that the speculum is covered or removed, or the sun is shaded from it, the *Fire* is left to its own free liberty, and instantly exerts its repulsive power, and by it diffuses and disperses itself equally into the circumambient air and other bodies that are in or near that place, and re-assumes its state of equilibrium and rest again; and would ever remain so without any particular direction, tendency, or motion, towards any one point, or part of space, more than towards any other,

other, in an equable expansion every way; if the continual motion of some other bodies did not collect the *Fire*, or the directing power of the sun put it in motion in parallel right-lines again, as will be more fully explained when we come to speak of the *laws of motion of Fire* hereafter. But this state of perfect rest never happens to all other bodies, neither does the sun ever cease to act on the *Fire* in all places at any one time. Consequently *Fire*, or some parts of the whole igneous mass, is always in motion, and puts the constituent parts of all other bodies whatever that we know into motion also, and thereby continues the growth, encrease, preservation, and continuation of all other created beings also, as will be more fully explained hereafter.

It clearly appears then from the preceding propositions and experiments, that *Fire* is a being which exists in a greater or less quantity in every part of space in the whole universe. And that it is a real body, which consists of the most simple, solid, hard, smooth, and the smallest spherical elementary particles of all matter. And that there is but one species of *Fire* existing in nature, which is immutably the same being in all places in the whole universe. Also that it is a body without gravity, and has no greater tendency towards any one part of infinite space, than it has towards any other part of space. And that it is a being which is endowed with a very singular and peculiar power of penetrating, pervading, rarifying, and expanding all other bodies in the whole universe. And lastly, That *Fire* is a body which exists in every part of space in a still state of equilibrium and rest, until that state of rest is changed, either by the motion of other bodies, or by the directing power of light from the sun: And that whenever these

two powers cease to act upon the *Fire*, it also instantly ceases to act in those directions which they gave to it; and restores itself by its *repulsive power* to its natural state of equilibrium and rest again, in which still state it would, or will for ever continue to remain, till it is acted upon and put into motion again by the same moving causes.

From all which singular and extraordinary as well as peculiar properties, thus discovered by experiments, to exist in, and belong to *Fire*, we must conclude that the principal motions and actions of *Fire* are, its wonderful power of penetrating, pervading, rarifying, and expanding all other bodies whatever, and thereby giving motion to them, or when too violent and great, by dividing and separating their constituent elements, and so dispersing, dissipating, and destroying them. From all which we must conclude, that this power of thus acting, must either arise from the power of *Fire* to be collected by the motion of all other bodies; or from the directing power of the sun, to put *Fire* in motion; or else it must arise from some extraordinary and singular power, which is either innate or conformed with, or given to fire, and is peculiar to itself, and not to any other body.

Let us then enquire by careful experiments, whether the motion and attrition of other bodies when sufficiently great, will not attract and collect this wonderful being called *Fire*, and cause it to act with great power and force.

And whether the sun or the light which is emitted from the sun, does not act upon this fire, and cause it to move and act with great power and force also.

And lastly, whether there is not such a thing as a *repulsive Power*, or Force, which is either innate, concreated, or conformed with, or super-added and given to *Fire*, which can cause it to dis-
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perse and penetrate, pervade and diffuse itself in and through all other bodies, and all space, in an equable manner again, when it has been so collected or directed in a greater quantity into any given space, by either of the above-mentioned causes, and thereby can restore itself to a state of Equilibrium and rest again.

And whether these three singular and peculiar modes of motion and action are not properly and truly *the laws of motion of Fire*; and are not sufficient to account for all the motions, actions, phenomena, and effects, which are produced by *Fire*, in a rational, clear, and satisfactory manner?

And however singular and extraordinary the preceding propositions, or how peculiar the *Properties of Fire*, discovered or demonstrated by them may appear to be, upon the first view; yet if it clearly appears from certain experiments that *Fire*, is really endowed with, and certainly has those peculiar properties, and that they are demonstrated to be real *Facts*, they certainly ought to be received as *Truths*. So likewise if the three above-mentioned *Laws of Motion of Fire*, can be demonstrated to be *True*, though they differ greatly from, or are even contradictory to the laws of motion of all other sorts of matter, yet if it can be made to appear, that these *Laws of Motion of Fire*, do neither interfere with nor impede or any way hinder other matter from acting or moving agreeably or according to the well known laws of motion of all other matter, these laws of motion of *Fire*, may be admitted as truths. We shall therefore not only endeavour to shew that the *Laws of Fire*, do not any way in the least interfere with the *Laws of Motion* of other *Matter*, or in the least impede or hinder any other species of matter, from moving and acting according to its own *Laws*: But we shall also

also endeavour to shew, or demonstrate, that if *Fire* was not so endowed with such peculiar properties, and possessed of or was not actuated by such *Laws of Motion*, as it will be made to appear to move and act by neither any animal or vegetable, nor several other created beings, could exist and subsist in that state, condition, and order, in which we see them now exist; neither could various other phænomena and effects be produced, and be rationally and satisfactorily accounted for by the known laws of motion of all other matter, without the assistance of the actions of *Fire*, and its *Laws of Motion*. But it is time to proceed to shew what these *Laws of Motion of Fire* are, and to endeavour to demonstrate the existence and truth of them.

Law I. *Fire is attracted and collected by the Motion and Attrition of all other Bodies.*

That *Fire* is attracted and may be collected in a very great quantity in any place, by the motion, friction, and attrition of all other bodies, even the softest, as well as the hardest, if their motions are but sufficiently quick and great. And that *Fire* is thus continually collected by the motion of other bodies, in one place or another, in every part of the universe, will appear from the following experiments.

Take two iron plates, as in the experiment before mentioned, p. 23. and let them be agitated with a very quick motion, and they will become red-hot, as if they had come out of a large fire. In this experiment we see that a great quantity of fire is attracted and collected out of the adjoining air, earth, and other bodies, and solely by the motion and attrition of the two iron plates one against the other, because there is no other cause
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to act or collect it ; and we also see that in a state of perfect rest, the plates will remain to be cold, and will collect no *Fire*.

Fire may also be collected in the same manner, by the motion and attrition of a hard body against a soft one : As by the friction and attrition of a glass globe against a soft cushion, as it is done in electrical experiments.

It also may be collected by the motion and attrition of the softest body that we know, i. e. air, against a hard body ; as let a large ball of solid iron be fired from the largest cannon, in the coldest winter day, in the coldest place, and it will pass with so great a velocity, as to move 600 feet in every second of time, through the cold air, from which it meets with great resistance and attrition ; and this attrition will be much encreased by the revolution of the ball on its own axis, so that no part of its surface, which rubs against the air, will pass in a streight direction, or in a right-line, but every point will describe so many cycloids, which must greatly increase its motion, attrition, and heat. And the ball when it has finished its course, and falls to the ground, will be found to be perfectly hot, although it had been continually exposed every moment to fresh cold air, and consequently must have lost every moment some part of the fire which it had collected before ; which must be a considerable quantity, as fire moves with great velocity when it passes out of bodies by its repulsive force. This heat of the ball cannot possibly be any part of it received from the fire of the gunpowder, because the wadding is interposed between it and the ball, which scarce remains $\frac{1}{1000}$ part of a minute exposed to the heat of the wadding, which never is burned through before the ball is gone : Consequently all its heat or *Fire* must be collected out
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of the air through which it passed, and that solely by the motion and attrition between the ball and the air.

We also may observe that *Fire* is attracted and collected by motion and attrition in water, and that in considerable great quantities too. Observe in a dark night, the sea-water at the stern of a ship, when she is under a brisk sail, and goes quickly; and you will see great quantities of refulgent fire continually arising from the keel and sides of the ship which are under the water, in apparent large bright fiery bubbles, which are left every moment behind the vessel in the sea. These all are real pure elementary *Fire*, which is attracted and collected by the motion, friction, and attrition between the bottom and sides of the ship, and the sea, though they exist and are seen in the water; it cannot burn or set the ship on fire, because water cannot be heated so hot, nor be made to contain so much fire as will burn wood; neither is its stay so long in contact with the wood, pitch, or tallow, as to ignite them, though it be real fire. And in a storm when the motion of the ship is great, and the agitation of the sea is violent, all the sea round the ship appears to be on a flame, from the great quantity of the fire, so collected by the violent motion and great attrition between the ship and the sea-water, though it cannot burn the vessel, for the reasons given.

Fire is also attracted and collected by the motion and attrition of two very soft bodies, viz. by the soft solids, and the soft smooth circulating fluids of living animals, i. e. by the motion and attrition of the circulating fluids, against their containing solids, the heart and arteries, and the reaction of these upon those; which being continued in a quick strong degree produces animal warmth and heat,

heat, and when they are continued in too great a degree for a considerable time, will collect too great a quantity of real *Fire*, which will produce that sensation which we call a great heat, or a violent fever.

For a fever is only a great encreased motion of our circulating fluids, which collects too much *Fire*, and produces a great heat; and is the means or method which provident *nature* makes use of, to exonerate and cast out of the body any infectious miasmata, or other noxious stimulating and irritating matter, that is gotten into our circulating fluids, which she endeavours to cast out of the body in the following manner. The infectious, or offensive matter, stimulates and irritates the sensible nervous coats or membranes of the heart and arteries, and that irritation causes them to contract and act more frequently and strongly on their contained fluids, and these more frequent and strong contractions greatly encreases the motion and velocity of the fluids, and consequently their action on their containing solids, both which again encreases the motion and attrition between and upon each other: And this encreased motion and attrition collects the *Fire* out of the circumambient air, adjacent earth, and other bodies; and that fire so collected, produces that sensation which we call great heat, or a high fever. And in reality all fevers, though from different *procatartetic* causes, are thus produced by and from *Fire*. And it may be demonstrated that the heat of every animal body, is as the momentum of its circulating fluids; and the heat of each part of an animal body, is as the momentum of the fluids, and the attrition between them and their containing solids in that part. Hence that sagacious father and prince of physicians Hippocrates, judiciously calls a *fever* by the

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expressive term πυρρός ἀπό τῆς πυρός, from *Fire*; probably as knowing more of the nature of *Fire*, as well as *diseases*, than most of his successors *. I hope the reader will pardon this long digression, as it probably may be of some service, at least to some readers.

Fire may likewise be collected by the motion and attrition of all other bodies whatever, either in a greater or less quantity: As by a flint and steel; by a hard piece of wood against a soft piece; and by the motion of mills, carts, engines, and all other machines, as before mentioned: In all which, the *Fire* is collected out of the air, earth, and other adjacent bodies, solely by the motion and attrition of the aforesaid machines, or bodies. (See Prop. I. III.) For this *Fire* thus obtained, is only collected by the motion of those bodies, and is neither new generated, nor new created, because poor impotent man can neither new create it, nor any thing else.

Hence it is evident both from all these and several other experiments, that *Fire* is a body which is attracted and collected into a given space, by the motion and attrition of all other bodies: And the greater that the quantity of motion and attrition are, the greater the quantity of the *Fire* so collected will always be. Hence the more solid, hard, and elastic, that any body is, the greater will the attrition, oscillation, and quantity of motion of its elementary particles on each other, and upon the elementary particles of the fire always be; and the greater that these are, the greater will the quantity of *Fire* collected thereby always be.

And we must also observe, that it does not appear from any observations, or experiments whatever,

* Τὸ μὴ γὰρ αὐτὸ δύνασθαι πάντα διὰ τῶνδε κινήσαι. ΗΠΙΟΚΡΑΤΗΣ ΠΕΡΙ ΔΙΑΙΤΗΣ. ΤΟ ΠΡΩΤΟΝ.

ever, that any body, or any species of matter yet known, does or can in a state of rest collect or attract any *Fire*. Neither does it appear from any experiments, or observations, that any other body, or any other species of matter, but that of *Fire* only, is attracted or collected by the motion and attrition of any other bodies. But on the contrary, we may observe that the constituent elementary parts of all other bodies whatever, are abraded, dissipated, and dispersed by motion and attrition, *Fire* only excepted. Therefore this extraordinary property, and singular power of being *attracted* and *collected* by *motion*, is peculiar to *Fire* only, and to no other body, or species of matter, that we are yet acquainted with. Wherefore we must conclude that *Fire* is a being, which *infinite Wisdom* has placed in a contrary state to that of all other matter, and has endowed it with this peculiar property, as well as with several others, as will appear hereafter, which are very different from those which are observed, and found in all other sorts of matter.

From all which it evidently appears, and therefore I think that we may justly conclude, and venture to assert, that to be attracted, or *attraction by motion*, is a law of nature or motion of *Fire*.

Law II. *The elementary particles of Fire are in a constant state of repulsion to each other: And the nearer they are brought to contact, the greater is their repulsive force from each other.*

This *law of motion of Fire* is also so directly contrary to the law of attraction, which all other matter is endowed with, that we are yet acquainted with, that I must desire my readers to suspend their judgment, till they have duly considered the following experiments: From which I hope it will clearly

clearly appear, that such a *repulsive power* is super-added to, or does really exist in and between the elementary particles of all *Fire*, and acts upon and repells them from each other, till the parts of the whole igneous mass of fire is brought into a state of equilibrium and rest, if not prevented by the motion and action of other bodies, or by the directing power of *light* emitted from the sun. And that this *repulsive power in Fire* is also the antagonist or counteracting power to the *law of attraction* which exists in, or is superadded to the elementary particles of all other matter; and that if *Fire* had not been thus endowed with this wonderful *repulsive power*, no other created beings could exist in that state and condition in which we are, and see them exist, without that power.

But what the true cause of this *repulsive power* is, still remains to be a thing which is yet unknown, and which I must confess I have not been able to discover*: No more than the great Sir Isaac Newton, or any other learned gentleman since *him*, have yet been able to discover the true cause of attraction or gravitation. But that the first is a power, which as certainly exists in all *Fire*, as the latter does in, or is superadded to all other matter (except fire only) will I hope be made evidently to appear by the following experiments: But as to the real cause of either of them, I think that all that we know, or can say of either of them is, *Sic voluit, et sic jussit DEUS.*

Let us ignite a large sphere of iron till it is red-hot, and suspend it in the air by a chain, whilst it is so hot; then let us place several thermometers which are graduated all alike, so that they may all rise

* If it be said that it is the elastic power or force of the elementary particles of the fire; it may be asked, what is the cause of that elastic power?

rise to the same degrees of heat, when they are applied to the same body: Hold these Thermometers, one on each side of the sphere, at the same distance from it, and the mercury will rise to the same height in all the Thermometers, and consequently will shew, that a great and equal quantity of *Fire* is *repulsed* out of and from each side of the sphere; and that in equal quantities in the same given time every way, both upwards, downwards, horizontally, and obliquely, each and every way alike. Then remove the Thermometers to a cool place, where they will not be affected by the sphere, ten minutes, then replace them at the same distances from the sphere, as before ten or fifteen minutes, and observe their height; then remove them from the sphere, and replace them at the same distances, as before every ten or fifteen minutes, for several times, till all the fire which was contained in the sphere, more than is in the circumambient air, is repulsed and escaped out of it; *i. e.* till the sphere is become as cold as the air is in which it is suspended; and then it will cease to emit any more fire, because the fire in the sphere, and that contained in the air, are reduced to an equal state of equilibrium and rest.

Here a great quantity of fire was collected into, and contained in the sphere, when it came out of the fire; and that fire, while it was in the sphere, was greatly compressed and in a condensed state, and had its elementary particles brought to a much nearer contact with each other, by the strong attraction of the constituent particles of the sphere towards each other: But the sphere being taken out of the fire, and no more fire applied to it, the fire, which was in the sphere was left to its liberty, and instantly exerted its *repulsive Force*, and by it escaped out of the sphere; at the first, whilst it was in a

condensed state, and had its elementary particles brought to a near contact, it was repulsed from the sphere in a great quantity, and with great velocity and force, as the rising of the mercury in the Thermometers plainly shewed; but as the fire in the sphere became less and less condensed, and its particles were further from each other, it was *repulsed*, and emitted out of the sphere, more gradually, and with a less force and velocity, and decreased in its quantity near in a quadruple proportion to the given times in which it was repulsed, as the rising of the mercury in the thermometers shewed; till at last, so much of the fire, contained in the sphere, was repulsed out of it, that no more fire was left in the sphere than there was in the same quantity of space in the circumambient air, it being reduced to a state of equilibrium and rest.

Here no repulsive power or moving cause, was added or given to the particles of the fire contained in the sphere, from any other body whatever, either to move the fire, or to encrease its motion; and yet, so much of the body of the *Fire* was repelled out of the sphere, as reduced the fire contained in it, to a state of equilibrium with that contained in the circumambient air. Consequently, this *repulsive power* must be conformed, connate, inherent with, or is a coexisting principle which is given to the *elements of Fire*: And is peculiar to *Fire* only, and to no other body, or species of matter, that we yet know, or are acquainted with.

It cannot be justly objected, that the reaction of the particles of the iron, repelled the particles of the *Fire* out of the sphere; because several experiments demonstrate that the action and reaction of the elements of the fire and the iron on each other

other do actually attract and collect the *Fire* by their vibrating motion, so long as that continues. And it most probably is this vibrating motion that contains the *Fire* in such bodies as the iron or sphere is, for so long a time after they are ignited; and is the cause why the *Fire* is not instantaneously repulled out of them, as it is out of the focus, in the following experiment.

Messrs. Villets of Lyons made a curious concave speculum of metal, exactly polished; the diameter of its circle measures its aperture to be 43 inches, and consequently the area of its plain, through which the rays of light from the sun are adnated, when opposed to it, is 1452 French inches; its focus is half an inch in diameter, and $3\frac{1}{2}$ feet distant from its vertex: Consequently if all the rays of the Sun which fall on the speculum, were reflected into its *Focus*, there would be 7396 times more *Fire* in that *Focus*, than in an equal space in the circumambient air heated by the sun at the same time; which is a most prodigious heat, and is the greatest degree of *Fire* that human art has yet invented; for the hardest metals are put in fusion in a moment; and even bricks, crucibles, and stones, are turned into glass in a moment, in that *Focus*.

Tschirnhausen, a German, made a dioptrical glass, the focus of which burned with great violence, though something less than that of *Villet's*. These two curious instruments, the one being a catoptrical speculum, and the other a dioptrical lens, may be so placed, that their focusses will meet in the same place; and the direction of the *Fire* from each, will coincide with the other, and their *Focuses* become one, but with contrary directions, from which a new attrition of the particles of the two *Fires*, on each other will ensue, which will

greatly encrease the heat, or *Fire*; though each was before, the greatest degree of *Fire* that human art has ever yet been able to produce.

Let this speculum, and this lens, be so placed, that their two *Focufes* may be thus united, and an inconceivable heat, and most violent *Fire* will be instantly produced: Then instantly cover both the faces of the speculum and lens with a white cloth, and in a moment all that prodigious great quantity of *Fire* is dispersed and gone; for if you place the easiest moved thermometer, the same moment that the cloth shades the speculum and lens, in the same place where their *Focufes* were united, but the moment before, it will shew no signs of greater heat there, than is in the circumambient air,

Here, in this experiment, there was a certain space into which there was such a prodigious great quantity of *Fire* directed and collected, that no body, nor any sort of matter yet known, could endure its force and power two moments, without being dissolved and dissipated, or destroyed: And in which space, no other body but *pure Fire*, did or possibly could exist. And as so great a quantity of *Fire* was collected into such a very small space; its constituent elements must be greatly condensed, and brought into the nearest contact that human art can contrive: Yet upon covering the faces of the speculum and lens, in a moments time all that prodigious great quantity of *Fire*, was dissipated, and equally dispersed every way and that solely by its own *repulsive power*; for no other body but *pure Fire* did exist in that *Focus*, either to encrease or give that *repulsive power* or force to the elementary particles of the *Fire*, by which it was thus instantly dissipated and dispersed. Neither could the progressive motion
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of the *Fire* towards that *focus* be the cause of its dispersing itself so instantly every way, because it came to that *focus* by two contrary and opposite directions, and consequently the elements of the *Fire* must strike against each other, and retard or stop their motion in that *focus*, therefore the repulsive force only must disperse them; and that not according to the directions in which they came to that *focus*, but equally every way alike.

Collect *Fire* any way, and put it to any proper pabulum of fire, and the action of the particles of the *Fire* upon the particles of the pabulum, and the reaction of these upon those will soon collect a very great quantity of *Fire*, which will continue there so long as that action and reaction of their elementary particles on each other continues; but the pabulum being consumed and dispersed, that action and attrition ceases, and the *Fire* instantly disperses itself into the air and adjacent bodies from whence it came, again by its *repulsive power* or force, and will remain in a still state till it is acted upon again by some other bodies.

Or collect the *Fire* by the means of an electrical machine into a proper receiver, and then apply a wire to that receiver to direct the motion of the *Fire*, and it will move and pass on through that wire with great velocity and force, and that solely by its own *repulsive power*; *qua data porta ruit*. Or let that *Fire* so collected remain in the receiver, and it will after the motion of the globe has ceased, soon disperse itself again into the bodies from whence it came, into the common mass of *Fire*, and that solely by its *repulsive power*, without any assistance from any other body, or power, in a silent imperceptible manner, without being perceived by any of our senses. Therefore this *repulsive power* must be a coexisting property, or conformed principle

with the elements of *Fire*, and is peculiar to it only, and to no other body or sort of matter that we yet know.

We observe that the nearer the constituent elements of all other bodies or matter, are brought to contact with each other, the more strongly they attract each other, and the more firmly they cohere. But we find that the elements of *Fire* are endowed with a directly opposite power, and are placed in a direct contrary state to that of all other matter, and the nearer that they are brought to contact with each other, the more strongly they *repel* each other. Can this proceed from any other cause, but from that *repulsive power* which the *infinite Creator* has endowed the elements of *Fire* with?

Therefore it appears sufficiently evident from the preceding experiments, that the elementary particles of *Fire* are in a constant state of *repulsion* to each other; and the nearer that they are brought to contact with each other, the greater is their *repulsive force* from each other: And as this extraordinary property or power of acting is observed to be in, and to attend all *Fire*, and that it most certainly moves and acts by this singular power, we may safely conclude that it is one of the *laws of motion of Fire*.

But as the great Sir Isaac Newton justly observes that, "Although the arguing from experiments, and observations by induction be no demonstration of general conclusions; yet it is the best way of arguing which the nature of things admits of, and may be looked upon as so much the stronger, by how much the induction is more general." I shall therefore add here a few *Corollaries*, both in order to confirm and establish this as a *law of motion of Fire*, and also to obviate any objections that may be made to them, by shewing that

that these *laws of motion of Fire* are so generally extended throughout the whole universe, that if all *Fire* (or some other such being in its place) was not so endowed with such properties, such power, motions, and actions, as we have endeavoured to demonstrate it to have, and to move and act by, that no other created beings could continue to exist in that state and condition, in which we see them exist.

COROLLARY I.

The *omnipotent Creator* has most wisely and beneficently endowed *Fire* with the above-mentioned peculiar properties, and this wonderful power, for many great and wise designs and purposes; even for no less than the secondary cause of the continuation and preservation of all created material beings, in that beautiful order, state, and condition, in which they now exist.

For if *Fire* had not been thus endowed with the wonderful power of penetrating, pervading, rarifying, and expanding, and so putting in motion the elementary particles of all other material bodies, there could have been no such things as life, motion, and sensation, in any animals; nor any such thing as vegetable or mineral life, or growth.

Because if *Fire* did not thus penetrate, pervade, rarify, and expand all other bodies, both solid and fluid, there could not have been any such thing as a fluid or liquid body: For water without any mixture of *Fire* with it, would be a hard, solid, transparent, frangible substance, like crystal, as we see it in ice, and not in a fine transparent liquid state; consequently if there was no water in a fluid state, there could be no vegetable juices, nor any motion of their juices; for if *Fire* did not pervade all ve-

getables, and was not put in motion by light from the sun, whereby their aqueous juices are rarified and expanded, and rendered lighter, so that the more condensed juices in their roots press upon them, and cause them to ascend and circulate, there could be no nutrition, accretion, or growth, or encrease, nor any such thing as vegetable life, or any vegetables to nourish animal beings with, without a due proportion and mixture of *Fire* in and with them.

And blood (supposing that there could be such a thing) without a due mixture of *Fire* with it, would be a hard, frangible, solid, red body, like a garnet, or ruby; consequently there could be no such thing as blood, or any other animal fluids in a liquid state; therefore no circulation of the fluids in animals, no nutrition, no growth or encrease, no sensation, motion, nor life, nor any such thing as an animal being existing.

Neither could there be any mineral life; no water, no motion in any of the mineral fluids, no apposition of parts, no nutrition, growth or encrease.

To be short, if *Fire* was not thus endowed with the above-mentioned peculiar properties, and wonderful powers, as in *Prop. IV. VI.* and if it was not subjected to be attracted and collected by the motion of all other bodies, as at *Law I.* there could be no such thing as fluids in a liquid state, neither any vital motion, internal or external, nor any such thing as life, or any living beings; but all created matter, and all material beings, would be one immovable, insensible, inactive, inert, solid cold mass, at perfect rest.

COROLLARY II.

And on the contrary, if the *omniscient Being* had not most wisely endowed *Fire* with this most won-

derful and peculiar *repulsive power*, by which it does dissipate, disperse, and diffuse itself equally through infinite space, and restore itself to a state of equilibrium and rest again, by *Law II.* when it has been collected in greater quantities into any given space, by *Law I.* all created beings, both animate and inanimate, would soon be burned, dissipated, consumed, and destroyed by *Fire*, in a very short space of time.

For if *Fire* was to be thus continually collected, as we observe it is by both the internal and external motions of all animals, according to *Law I.* those vital motions would in a very short space of time collect such a great quantity of *Fire*, as would soon consume and destroy them, as we see it sometimes does in violent fevers; and the quantity of *Fire* so collected, would be much greater if that *Fire* so continually collected, was not as continually emitted, dissipated, and dispersed again, by this its own peculiar *repulsive power*, as before demonstrated, *Law II.*

So likewise if this earth, and all the other planets and celestial bodies, which are always in motion, did continue by their quick and rapid motions, constantly and continually to collect this *pre-existing Fire*, in such great quantities, as it is evident they do, they would soon collect such a prodigious great quantity of *Fire*, as would soon burn, consume, and destroy them, and all the beings which inhabit them, if that *Fire* which they so continually collect, was not as continually repulsed, dissipated, and diffused through infinite space again, by the above-mentioned peculiar and extraordinary *repulsive power*, which *infinite Wisdom* has given to *Fire* for these great and wise purposes.

And thus we see how near to utter destruction we often are, if *infinite Wisdom and Goodness* had not
or-

ordained and provided a secondary means for our preservation ; though mankind in general are so vain as to think themselves wise and knowing, yet we often grovel on in ignorance, without either seeing the dangers, or the means appointed by *Divine Providence*, for our preservation.

C O R O L L A R Y III.

Fire is not only thus collected by the motion and attrition of all the planets, as before ; but it is collected in different quantities, in the different parts of those planets, in proportion to the different quantities of motion in those parts, as appears from the following observations.

It is observed that it is always very warm between the tropics, and very cold at the poles of the earth ; which I apprehend must proceed solely from the different quantities of motion and attrition between the surface of the earth, and the incumbent atmosphere, in those different parts of the earth.

For as the earth revolves on its axis once in every 24 hours, the motion of every point of its surface at, or near to the equator, must be much greater than it is at, or near to the poles. As the great circle of the earth at the equator is computed to be $25031 \frac{1}{2}$ English miles, and the time of its revolution is 24 hours, every point of its surface there must pass through the space of $25031 \frac{1}{2}$ miles in every 24 hours : But as no point of the surface of the earth describes a right-line but that of a cycloid in each revolution ; and as the length of every cycloid is four times that of the diameter of its generating circle ; and as the diameter of the earth at the equator is said to be 7967 miles, consequently every point of the surface of the earth near the equator, must pass through the space of 31868 miles

miles in every 24 hours time ; which is $1327 \frac{3}{4}$ miles every hour, or near $22 \frac{7}{8}$ miles in every minute ; which is an exceeding swift and rapid motion, and must produce a great attrition between it and the air of the atmosphere, and consequently must continually collect a great quantity of *Fire* or heat. When at the same time every point of the surface of the earth, at one degree or 60 miles distant from the pole, will only pass through the space of $377 \frac{1}{4}$ miles in every 24 hours time, or $15 \frac{1}{4}$ miles in each hour ; which is little more than half a mile in each minute . Which motion will cause but very little attrition, and consequently will but collect very little fire there, viz. near one forty-fourth part of the quantity of fire which is collected by the attrition at the equator (if we suppose that the quantity of fire collected by the motion of bodies, is as the quantity of motion and attrition directly, as it appears to be, from what experiments I have made.) From this calculation then, the quantity of fire collected at the equator will cause Fahrenheit's thermometer to rise as high as 88 degrees ; when that collected at one degree distant from the pole, will only cause it to rise as high as No. 2. or near it, which is 30 degrees colder than the freezing point, and is very near what they are both found to be by observation ; (though no man has yet been quite so near to the pole as one degree from it ;) but as the repulsive motion of fire is found to be so very quick, it is probable that the quantity of fire even at the pole, and some degrees distant from it, even as far as Iceland, is near the same, where it is sometimes found at No. 2. and sometimes as low as No. 0. and is probably as near the truth in them both, as the nature of such a calculation will admit of.

Yet

Yet we observe that a much greater quantity of light is emitted from the sun, in right-lines to the pole, in the summer time, than there is emitted to any one part of the equator; but as there is very little *Fire* collected at, and near to the poles, it is always found to be very cold there: And on the contrary, it is always very warm at the equator, as the attrition is so great there, though it receives not much more than half the quantity of light from the sun, which the poles receive in the summer time: Consequently if that *Light* which is emitted from the *Sun* was real *Fire*, as is generally supposed, it would be much warmer at the poles, especially in the summer time, than it is at the equator; which is contrary to all observation and fact. This also confirms the opinion hereafter mentioned, that *Fire* is not emitted from the sun, as is commonly supposed, but *Light* only, which will be proved to be a different being.

And inasmuch as the earth and all the other planets do thus by their quick and rapid motions, continually collect such great quantities of *Fire*, they would be soon burned, consumed, and destroyed, if *infinite Wisdom* had not thus most wisely and providentially endowed *Fire* with the above-mentioned wonderful *repulsive power*, by which it can dissipate and disperse, and does restore itself to its state of equilibrium again, as before-mentioned, when it is so collected.

COROLLARY IV.

From these laws of motion and action of *Fire*, we may also clearly account for another extraordinary phenomenon of nature, viz. Why the snow continually lays upon the tops of the Anades or Cordelier mountains, under the equinoctial line, and

and between the tropics in Peru, where it is thought, and is commonly found to be so hot.

These mountains are said to be three miles perpendicularly high, and are allowed to be the highest hills in any part of the earth yet known; however the great geometricians Messrs. Condamine and Bouguer * found them to be 2200 French toises, or near to $2\frac{1}{2}$ miles and 488 yards near $2\frac{3}{4}$ miles perpendicular high; and they also say that their tops are continually covered with snow; and as they have been so covered with it ever since the Spaniards came there, we may conclude that they have been so covered with snow ever since the creation; though the valleys at the bottom of those mountains are always very hot, as in all the other parts of the earth that are between the tropics; but the tops of those mountains being elevated so much above the common surface of the earth, they are like so many points which are elevated so high up in the air, where we are told by those who have been there †, that the air is always found to be exceeding light, thin, and rare, and consequently the pressure of the atmosphere on the tops of those mountains must be greatly diminished, and is so very light and small, that the friction and attrition between the surface of the tops of those high hills, and that thin light atmosphere will but be very little, and consequently the quantity of *Fire* which is col-

* See Mons. Condamine's Voyage down the River Marañon, &c. And Bouguer's Measure of a Degree at the equinoctial Line.

† We are told by some voyagers, that the air on those mountains is so very light, thin, and rare, that men standing upon them, though not near any precipice, are very giddy; and the blood-vessels (from the pressure of the air being so much diminished) frequently burst, and produce hæmorrhages; and that they breathe whilst they are there with some difficulty. See Gage's Survey of the West-Indies, p. 88.

collected there by that little attrition, must but be very small also, and never in such a quantity as to be sufficient to dissolve that snow; wherefore it is always cold on those hills, though they are within the tropics, where it is so very warm or hot in the valleys below.

Yet the tops of those high mountains, are as much nearer to the sun, as their height is above the bottoms of the vallies, and are very rarely, or never covered with clouds, neither are the rays of light coming from the sun to the tops of those hills, seldom or ever intercepted by the clouds; consequently the tops of those mountains ought to be so much warmer, as they are higher and nearer to the sun, than the vallies are, if the *Fire* was emitted to them from the sun: But the contrary being true, it is another confirmation that the rays of *Light* emitted from the *Sun*, are not *Fire*; and that *Fire* is a different being from *Light*, and is not emitted from the sun to us on the earth; as will be more fully explained hereafter.

C O R O L L A R Y V.

This collection of *Fire*, by the motion and attrition of all other bodies, in the coldest and darkest places will also clearly and satisfactorily account for the production of *Volcano's*, as that of mount *Hecla* in Iceland, and in all other warmer places: and most probably for the production of all earthquakes also; and in the like manner for the production of all hot medicated mineral waters, as well as for the production of many other extraordinary phenomena in nature.

That curious experiment of that able chymist *Homburg*, by mixing a large quantity of *Sulphur Vivum*

Vivum with an equal quantity of filings of iron, and wrapping them up in paper, then placing them in, and covering them with ^{earth} and letting cold water drop gradually upon them, and in a little time they began to grow warm, then to expand and swell, and some time after to emit smoke, and at last to burst out into a flame; only by the addition of the cold water to them, which produced a fermentation, and the motion and attrition between their particles in their fermentation, collected so much *Fire*, as to produce that flame, as the sulphur is a combustible body.

And thus from a strong fermentation, or rather effervescence and great motion and attrition of different mineral bodies, either brought together by the means of water, or caused, to grow or encrease, so near each other, as to join or mix, till at last the motion and attrition of their elements on each other, are so great, as to collect a great quantity of fire, which being joined to a sufficient quantity of pyrites or sulphur, or some sulphurous combustible bodies is still encreased, both in quantity and motion, action, rarefaction, and expansion, till they are ignited and burst out in flames, and so produce earthquakes, and volcanos, where it meets with a sufficient quantity of combustible matter; and when those mineral bodies are in, and mixed with water, they produce warm, or hot mineral waters fit for medicinal uses.

Law III. *Fire is put in motion in parallel right-lines by light emitted from the sun, and caused to move with force, and produce heat and more light.*

It has been demonstrated before, that *Fire* exists in every part of space, though it may not be per-

perceived at the same time by our senses, until it is put in motion in right-lines, by light emitted from the sun; and thereby caused to move with great velocity, and act with force; which is also confirmed by the following observations.

Observe at midnight within the torrid zone, when the moon is at its change, and the heavens are perfectly clear and serene; survey and examine the sky, and nothing lucid can be seen in all that immense space, but the stars; no light from the sun appears in the whole hemisphere, except the inconsiderable small quantity which the planets then in view receive from that luminary, and reflect to the earth: And yet we are certain, that the rays of light from the sun, at that time, strongly enlighten all that hemisphere, except that small cone, whose base is a great circle of the earth, which consequently is not illuminated by the rays from the sun. Though even that dark cone, is at the same time so much filled with real *Fire*, where the observer then is, as to cause the mercury in *Fahrenheit's* thermometer to rise as high as 80 degrees, which is very warm; yet no light will appear, nor will any fire be perceived by any person placed in that cone, except by the warmth which he feels: And if the observation be made in a cold climate, no fire will be any way perceived by any of his senses.

Hence it appears, that no light can be discerned by a person, unless he be so situated, that a right-line may be drawn from the body of the sun to his eye; or that those direct rays, may be reflected from some other body in a right-line to his eye; though the same place be ever so brightly illuminated by the solar rays, or with a considerable great quantity of fire in a still state at the same time, unless that fire be put in motion in right-lines.

Admit

Admit the rays of the sun through a small aperture into a room that is perfectly darkened, and cover the base of that small cone which the rays form through that small hole, with a body that is perfectly black, and no light will appear in that room, unless the person's eye be placed in that enlightened cone, except a very little which is reflected from the atoms floating in the air, though a great quantity of *Fire* is in that room at that time : Neither will a concave speculum, or a convex lens, collect any of that *Fire*, or produce any heat in their focuses in that room, unless they be placed in that enlightened cone, in which the pre-existing *Fire* is put in motion in right-lines, by the rays of light admitted through the hole from the sun ; though so much *Fire* existed in a still state, in that room at that time, as caused the mercury in Fahrenheit's thermometer to rise as high as 86 degrees.

Here a great quantity of *Fire* existed in this darkened room, but produced no *Light* except within the cone, where the rays of light from the sun were admitted ; because all the particles of the fire in the room, except those which were in the cone, were in a state of equilibrium and rest, as they were not acted on and put in motion in right-lines by the light emitted from the sun. But the moment that the windows were opened, and the rays of light admitted from the sun, they instantly put the particles of the *Fire* which were in a still state in the room before, into motion in parallel right-lines, and caused them to move and act, and produce light and heat ; and then these parallel right-lines of *Light* and *Fire*, when so put in motion, being received on the faces of the speculum and lens, were reflected and refracted into their focuses, where they burned with great violence.

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So

So likewise the thermometer being now placed opposite to the sun in the room, where the fire was put in motion in right-lines, by the rays of light coming directly from the sun upon it, they instantly caused the *Fire* to move with great velocity and force, and soon caused the mercury in that thermometer to rise to 130 degrees: But in such places in the room as the rays of light were not admitted in a direct line from the sun to the thermometer, the mercury still remained at 86 degrees.

Hence it appears that the sun is endowed with a power of causing the elementary particles of this *pre-existing Fire* to deflect from their natural tendency from the center of their sphere, to its circumference, and directing them into parallel right-lines, and causing them to move and act with great velocity, power, and force. Therefore the sun is the mover and director of this *Fire*, and greatly encreases its power of acting, by giving it this parallel direction and quick motion, without making any addition of new *Fire*, or any supply of any igneous matter from the body of the sun, or any new production of *Fire*, from any thing that was not *Fire* before. And we observe that whenever this rectilinear impulse of light from the sun, which thus gives the pre-existing *Fire* its parallel direction and rectilinear motion, is either intercepted or removed, that rectilinear parallelism of the *Fire* instantly ceases also; and the *Fire* as instantly re-assumes its *repulsive power*, and its natural tendency equally every way, till it is restored to its state of equilibrium and rest again.

Hence we may conclude, that this rectilinear parallelism of *Fire*, is the cause of its motion and power of acting with such force: And that the *Sun* gives the *Fire* that parallel rectilinear motion and power. Also that no other body but the *Sun*,
that

that we yet know, can put this pre-existing *Fire* in such motion and action in parallel right-lines. Therefore this motion and action of *Fire*, by the impulse of light from the *Sun*, is one of the *laws of motion of Fire*.

I think the learned professor Boerhaave was the first person (at least that has left it upon record) that supposed *Fire* was not emitted by, and sent to us on our earth, from the *Sun*. And the more that we examine and enquire into this opinion, the more we shall be convinced of the truth of it. He with *his* usual great modesty says; “*Dubitavi diu, auderemne tandem publicare sententiam quam diu mecum coxi, atque recoxi? Facilitate vestra usus, en id facio. Credibile videtur in actione ignis, hic apud nos deprehensa, nulla solem emittere materiem igneam cui illa actio tribuenda videtur. Hanc vero solem potentiam tantum habere, ut præ-existentem in illo eodem loco ignem, non auctum, dirigat in rectas parallelas. Unde illa eadem copia ignis ex parallelismo reflexa, vel refracta, colligatur, solaque ex dispersu adunatione, atque inde sequente nova vi, omnia agat.*”

And to confirm this opinion, *he* gives us an experiment made with a hollow brass cube. See his *Element. Chem.* Vol. I. p. 252. And another made with Villet's speculum, which I shall here translate.

“*Let Villet's speculum be directed to the meridian sun, but be covered with a very white cloth, then there will be no more fire or heat in the cavity between that covering and the speculum, than there is in the circumambient air. Remove the covering, and in an instant the fire that was in the cavity of the speculum, and tended every way equally, is driven in parallel lines upon its concave surface, and from thence*

“ is reflected into the focus, and produces a most
 “ violent *Fire* there, which in reality did not pro-
 “ ceed from the *Sun* : Nor is there really either
 “ more or less *Fire* than before, but it is only de-
 “ termined in a different manner. In a refracting
 “ lens too the case is exactly the same. Hence
 “ then neither the fire produced by this speculum,
 “ or by the lens,” (*or that collected by the attrition*
of bodies) “ does upon this supposition depend at
 “ all upon the *Sun* with regard to its igneous mat-
 “ ter.”

But as light is supposed to be emitted from the sun with so great a velocity, as to pass from it to the earth in the space of ten minutes time ; *Fire*, if emitted from the sun, may be supposed to pass to the earth with the same velocity, and in the same given time ; and then the time of its passing from the white cloth to the speculum, will appear to be instantaneous, or so short that our human senses cannot distinguish or divide time so minutely ; consequently this experiment may not be so clear and conclusive, as may be desired, on either side of the question ; yet this opinion of the *Fire* not being emitted from the *Sun*, may nevertheless be true ; and probably both some very rational arguments, and some experiments, may be produced to confirm the truth of it ; or at least to render it much more rational to suppose that *Fire* is not emitted from the *Sun*, than to suppose that it is. We shall therefore examine some of the arguments and objections both *pro* and *contra* ; and first some of the insuperable objections and difficulties which attend the supposition of all the *Fire* being emitted from the *Sun*.

That the *Sun* emits the *Fire* from its body to the earth, and every part of the solar system, is an opinion which has been entertained and believed in all
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ages, is certain : And any opinion that is contrary to this, must expect to meet with great opposition ; more especially as the great Sir Isaac Newton seems to have entertained that opinion : Which probably arose from its being generally received, and *his* not having made more experiments and further enquiries into the mysterious nature and subtile properties of *Fire* than *he* did : Hence *he* was induced to think that *Fire* and *Light* were the same beings ; wherefore *he* was also induced to superadd a third subtile being, which *He* calls *Æther*, which we humbly apprehend is only this *pure Fire* ; and we also hope that it will be made to appear that *Fire* and *Light* are two different and distinct beings. And no doubt but if that great *Philosopher* had made further experiments on *Fire*, as *He* did on *Light* and *Colours*, *His* great genius would have led him to make much greater discoveries than have been yet made, and we should have known much more of the nature and properties of *Fire*, and *its laws of motion*, than we now do, or hope to know. I pay the greatest deference to *his memory* and to *his opinions*, but I must pay a greater to *truth*.

Let us suppose then that all heat or *Fire*, which exists in infinite space, or in the immense compass of the solar system, has been and still is emitted from the body of the *Sun*, equally every way in right-lines, and that continually every moment of time, from the first creation of it, to this time, in such a prodigious great quantity, that a circle whose diameter is 43 inches, which is the diameter of Villet's speculum, being placed at the distance of 81,000,000 of miles from the sun, as that is the supposed distance of the earth from the sun, can collect every moment of time, such a prodigious quantity of *Fire*, that when it is reflected into its *focus*, it melts, burns, and consumes all bodies

whatever in a moment. And suppose a great hollow sphere, whose internal surface is 81,000,000 of miles distant from the sun, to have its whole internal surface divided into as many such small circles, the diameter of each of which is 43 inches, as that great sphere contains, which is very near 2223276027046743431 such circles, and that each of those circles has continually received every moment of time, from the creation of the sun, to this day, such a prodigious quantity of *Fire* from it, as to burn with that irresistible force; and that this *Fire* is emitted from the *Sun*, with such a great velocity, as to pass through that great distance of 81,000,000 of miles in ten minutes time, and that successively and continually every moment from the first creation of the sun, to this day. How immensely and inexpressibly great must this quantity of *Fire*, which has been thus emitted from the *Sun*, be! And how inconceivably great must this constant consumption, and continual waste or loss of *Fire*, be! And yet it does not appear either from the most authentic ancient or modern accounts, or from their best observations, that the body of the sun is in the least diminished; or that it emits any less quantity of fire now, than it did at the first beginning of time. Neither does it appear from any observations ancient or modern, that the quantity of fire in this earth, or in its atmosphere, is in the least encreased, or that we have either more or less *Fire* now, than there was on and in the earth, in the first ages of the world.

And it may be asked, what is become of all this immense quantity of *Fire*, which has been thus emitted from the *Sun*, in all this past time: It is not in the least probable that the same *Fire* is re-mitted back again to the *Sun*: Because if it is re-mitted, there must be a repelling power sufficiently great

great to remit it, and some body or being to exert that power; and that power, wherever it be, must be greater, and have a stronger repelling force, than the propelling force, or emitting power of the *Sun* is, by which it sends the *Fire* from its body to the earth in ten minutes time, or else the *Fire* would be repelled back again to the earth, by the emitting power of the *Sun*: And if the repelling force by which the *Fire* is supposed to be remitted back again to the *Sun*, be greater than the expulsive or emitting power of the *Sun* is, then no *Fire* could be emitted from the *Sun* to the earth. But no such power, nor any body endowed with, or that can exert such a remitting power, is known to exist in any part of space that we have any knowledge of: Neither do any observations or experiments make it appear in the least probable that any *Fire* is remitted back again to the *Sun*. But on the contrary the *repulsive power* which is in *Fire*, causes it to tend as much from, as it does towards the *Sun*, and every way equally alike, till it is restored to a state of rest, as has been demonstrated before.

It may also be further asked, if that immense quantity of *Fire* which has been thus continually emitted from the *Sun* ever since its creation, is not remitted back again to it, what is become of all that immense quantity of *Fire*? I presume that none will say that it is annihilated, because that is too unphilosophical and absurd an opinion to be admitted: And if it is not annihilated, where, or in what part of the universe, does it exist?

Hence it appears that this hypothesis of all *Fire* being emitted from the body of the *Sun* to every part of space, is not only thus clogged and loaded with these insuperable difficulties and objections, but with some others which cannot be reconciled to a rational system, or to that beautiful simplicity

and regular order, which *infinite Wisdom* has ordained, and agreeably to which we may observe that *nature* always acts.

But the contrary hypothesis which is here proposed, is not attended with any of these insuperable difficulties, but is founded on observations and experiments, and is conformable in all its parts, to that most beautiful simplicity and order, which *nature* always observes in all *her works*.

Infinite Power having created *Fire*, and caused it to exist in every part of space, most wisely endowed the *Sun* with a power of acting upon, and causing that *Fire* to move in parallel right-lines, with great velocity, power, and force, and thereby to produce many wonderful and extraordinary effects, as before demonstrated; has also endowed this *Fire* with several other singular and peculiar properties, as before explained; by which it appears that this *Fire* may not only be collected in a prodigious great quantity by the motion and attrition of other bodies, and the application of proper pabulum to it, in the coldest night, and coldest place, when and where the *Sun* has no influence upon it, either to act upon or direct it in any respect whatever, because the earth is interposed between it and the *Sun*. See *Prop. I.* But *Fire* is also endowed with a singular and most extraordinary power of penetrating, pervading, rarifying, and expanding all other bodies whatever, as has been demonstrated before, *Prop. IV.* And likewise with a no less wonderful power of restoring itself to a state of equilibrium and rest, when that state of rest has been changed, either by the motion and attrition of other bodies, or by the directing power of *Light* from the *Sun*; which power we have here called its *repulsive power*, *Law II.* and *Prop. VI.* Hence it appears that *Fire* is a being which can exist,
move,

move, and act with great power and force, independently of, and without receiving any direction or power from the *Sun*; consequently *Fire* must be a different and distinct being from, and independent of the *Sun*. Yet it is nevertheless a being, which is so formed and fitted by the *Divine Creator*, as to be acted upon, and put in motion by *Light* emitted from the *Sun*: And we evidently see, that the instant that the sun appears, and its rays of light are admitted to the *Fire*, they put the elementary particles of the *Fire* in motion in parallel right-lines, and cause them to move with great velocity, and act with great power and force.

This *pre-existing Fire* being thus wonderfully formed and endowed with the above-mentioned extraordinary and peculiar properties and power of acting, as before demonstrated: There is no necessity for any new supply, addition, or new creation of more *Fire*; nor yet for destroying or annihilating one single elementary particle of *Fire*: Neither do any observations or experiments make it appear that so much as one single elementary particle of *Fire* ever has been either *new created*, or *destroyed*, since the first formation and creation of *Fire*: Neither is it in the least probable that there is either one particle of *Fire* more, or less, than there was immediately after its first creation.

Fire then is a being which is endowed with peculiar properties, and is subjected to singular laws of motion, which are peculiar to itself only, and moves by and agreeably to them, and acts upon all other bodies, and produces all its wonderful phænomena and effects by them; yet is reacted upon by other bodies by their laws of motion, and by light from the *Sun* in a peculiar manner; yet still remains to be the same being, without any diminution or encrease of its first created quantity of igneous matter.

If *Fire* then is not emitted from the body of the *Sun* to the earth, and the other planets, and yet the *Sun* is found to give *Light* and heat to them; it remains that we enquire how the *Sun* acts: so as to produce them on this earth and the other planets, at so great a distance from them, so as to put this pre-existing *Fire* in motion, and produce *Light* and heat on them. Let us try if the following experiments will give us any light or assistance in this subtile and mysterious enquiry.

It appears then from the preceding experiments, that *Fire* is a being which exists in every part of space; but does not produce or give *Light*, unless it be put in motion in parallel right-lines, either by the acting power of the *Sun*, or by the action and reaction of other bodies upon it, or by its being put in motion by some other cause, and is not seen whilst it is in a still state. It is also demonstrated that the *Sun* is endowed with a power of putting this pre-existing *Fire* in motion, and that it actually does put the *Fire* in motion in parallel right-lines, and that this parallelism of the *Fire* produces both *Light* and heat.

It consequently follows, that either the body of the *Sun* can act upon, and put this pre-existing *Fire* in motion on the earth at the immense distance of 81,000,000 of miles from it, or at still a much greater distance from it as on Saturn; or that something is emitted from the *Sun* to the earth, which can act on the *Fire*, and give it that motion; and that something which is so emitted, and acts on the *Fire*, must be *Light*; because it does not appear that any other body but *Light* is emitted from the *Sun* to the earth; and that *Light* is so emitted is evident and certain: Therefore *Light* must be a distinct and different body from *Fire*. Let us then
endea-

endeavour to demonstrate by some other experiments, that *Light* and *Fire* are two different beings.

First, It is evident, and universally acknowledged, that the Moon is a body which has no *Light*, but what it receives from the *Sun*.

Then let us place a concave speculum, as that of *Villet's* (with which the experiment has been made) opposite to the moon when she is at the full, in a serene cold night, and the *Light* which the moon receives from the *Sun* will be reflected from it upon the speculum, and from thence into its focus, where a most resplendent and refulgent *Light* will be seen, almost equal to that received and reflected by the same speculum from the sun, only a little paler: Then place a thermometer, which is easily moved, by the least degree of heat or *Fire*, as that of *Drebbellius*, in that refulgent focus, and we shall find that the air in the thermometer will not be the least expanded or moved; and shews that there is no more *Fire* in that *Focus*, than there was before the resplendent *Light* was collected there, or was then in the circumambient air, though so great a quantity of *Light* was in that focus at the same time. This experiment demonstrates that a great quantity of very bright refulgent *Light* may be collected, and can exist alone in a given space, without any addition of heat, or any encrease of the quantity of *Fire*. It also shews, that this *Light*, which comes from the *Sun*, is when thus reflected from the moon, so changed in its power of acting on *Fire*, that it has totally lost its power of putting the pre-existing *Fire* in motion in parallel right-lines, and producing heat. The same experiment being made, though with a much less speculum, within the torrid zone; where so great a quantity of *Fire* existed in the
common

common air, where the experiment was made, that it caused the mercury in *Fahrenbeit's* thermometer to rise as high as 80 degrees; yet the reflected *Light* from the moon, which was so refulgent in the focus of that glass speculum, did not in the least act on that pre-existing *Fire*, so as to put its particles in motion, nor produce the least encrease of *Fire* or heat. Hence it is evident, that as this great *Light*, neither acts as *Fire*, nor produces the same effects which *Fire* does, it consequently is not *Fire*.

Several experiments also demonstrate that a great quantity of *Fire* may exist in a given space, without producing any *Light*.

Observe in a dark night, within the torrid zone, and no *Light* appears, except that little which is reflected from the stars and planets then in view; yet a thermometer shews us by the mercury rising as high as 80 degrees, that a great quantity of *Fire* really exists in that place at that time. Or take a piece of iron, and ignite it in the fire till it is just beginning to shine, then take it from the fire into a dark place, and there will be no appearance of *Light* in it, nor will any light proceed from it; yet if we apply it to any part of our body, it will burn and consume the flesh, even to the very bone: Or if, we apply it to any proper dry fuel, it will soon burn, and give both light and flame, though no light could be seen in it before.

Here then a considerably quantity of *Fire*, did really exist in a certain given space, without any *Light*.

Consequently, as a great quantity of *Light* can exist alone without any *Fire*; and a great quantity of *Fire* can exist alone without any *Light*; they
must

must be two distinct and different bodies or beings.

Since *Light* and *Fire* are found to be two distinct and different bodies; let us enquire a little further into the different natures of these two subtile bodies, in order to discover whether they are subject to the same, or to different *laws of motion*?

Light is a body which is emitted from the *Sun* with so great a velocity, that the great Sir *Isaac Newton* computes that it passes from it to the earth, which is said to be 81,000,000 of miles, in ten minutes of time; and acts upon *Fire*, and on all other bodies.

Fire is a body which exists in a still state in every part of space, till it is put in motion either by *Light*, or by the motion and attrition of other bodies, and produces no *Light*, till it is so put in motion; and is a being which is not emitted from the *Sun*.

Light is a body which is emitted from the *Sun* with a quick and strong projectile motion, and may be reflected back, or any other way, from other bodies with great velocity, to the greatest distances; as other bodies sent with a projectile force are, till their gravitating force and the resisting power of the air, destroy, or overcomes that projectile force of them; but the projectile force of *Light* seems not to be lessened or destroyed by the air, as the reflection of light from *Jupiter* and *Saturn*, and from their satellites seems to shew.

But *Fire* is a body which cannot be reflected back again from other bodies to any great distance, because its *repulsive power* overcomes and destroys that projectile motion, and restores it to its state of equilibrium and rest, by causing it to move equally every way till it has acquired that state of equilibrium.

Light

Light alone never produces any degree of sensation of heat.

But *Fire* always produces some degree of heat, either more or less within the sphere of its action.

That *Light* alone produces no heat is demonstrated before, p. 63. And both this, and also that *Fire*, is not emitted from the *Sun*, are confirmed by the following observation. It is observed that a much greater quantity of *Light* is emitted from the *Sun*, to the earth at the subpolar regions during the summer months, when the *Sun* is seen above the horizon for many weeks together, than there is emitted to places which are situated within the Torrid Zone, where the *Sun* is not more than thirteen hours above the horizon in each natural day; and consequently if that *Light* was *Fire*, which was so emitted from the *Sun*, it would be warmer at the Pole at that time, than it is at the equinoxial line, notwithstanding the obliquity of the rays of *Light* when they fall on the earth, since they pass in a right-line from the *Sun* in equal quantities to the earth there, as they do to the earth between the tropics; yet all observation informs us that it is exceeding cold in those subpolar regions, and very warm within the tropics. This great coldness at the poles must therefore arise from the much less quantity of motion and attrition of the surface of the earth against the air of the atmosphere at the poles, than there is at the equator; and consequently a much less quantity of *Fire* must be collected at the poles, than at the equator, and therefore is much colder there, tho' the first receives much more *Light* from the *Sun* than the latter does. And as the quantity of motion and attrition of the surface of the earth is much greater against the atmosphere at the equator,

tor, than it is at the poles ; consequently a much greater quantity of *Fire* must be collected there, therefore a much greater degree of heat will always be found at the equator, though it receives much less *Light* from the *Sun*, especially in the summer season ; and that it is so, is confirmed by all observation. See Corol. III. before. Therefore it is not *Light* that produces any heat or *Fire* of itself alone, but by its power of putting the pre-collected and pre-existing *Fire* in motion in right-lines, which then produces heat.

Light is a being which is put in motion by the *Sun* only.

But *Fire* is a being which is put in motion both by *Light* from the *Sun*, and by the motion and attrition of all other bodies ; and also by its own repulsive power.

That *Light* is put in motion by, and is sent from the *Sun* to the earth, is evident and certain. And that *Fire* is put in motion both by the *Light* emitted from the *Sun*, and by the motion of all other bodies, has been demonstrated before, *Law* I. III. And when the *Fire* is so put in motion by *Light*, or by other bodies, it acts with great power : And when those bodies cease to act upon the *Fire*, it also ceases to act in that direction which they gave it ; and instantly exerts its *repulsive power*, *Law* II. And its elementary particles are by that power dissipated and dispersed equally every way, and are thereby restored to their natural state of equilibrium and rest : In which state they will continue, till they are put in motion again by some of the same moving causes.

Fire is a subtile being which easily and readily penetrates and pervades all other bodies whatever, both solid and fluid, as has been demonstrated before, *Prop.* IV.

But

But *Light* is also a subtile being which does not penetrate any other bodies (the black and diaphanous excepted) but is reflected easily and quickly every way from them, even to the greatest distances, without retarding or deflecting each others rays from their direct tendency.

The rays of *Light* which are reflected from Jupiter and Saturn, and their satellites, and also from the fixed Stars, confirm this, as they pass across the rays of *Light* which are emitted from the *Sun* every way through the superior regions, before they reach to us on the earth, without being obstructed or deflected; which is also further confirmed by the following experiment.

Let two plain speculums be placed at a moderate distance from each other, with their faces opposite and perpendicular to each other; then place a lighted candle in the middle distance between them, and the image of the candle will be seen multiplied to a great number of candles in each speculum in a moment. This multiplicity of candles seen in the speculums, all arise from the reflection of the rays of *Light* from the candle first, and then from the reflection from one speculum to the other, so many times as there are lights seen. And all those rays of *Light* pass backwards and forwards, so many times nearly in the same direction, without obstructing, retarding, deflecting, or hindering each other in their motion.

Or receive the rays of *Light* from the *Sun* upon a plain speculum, placed in a large room, and turn the glass so as to reflect the rays of *Light* from it upon another speculum, and so on to many more glasses, in such a manner that the rays of *Light* may cross, return directly, obliquely, and in every direction, and you will find that all those rays of *Light* will pass.

pass every way with freedom and ease with great velocity, without obstructing, deflecting, or interrupting each other from their direct tendency.

As *Light* is such a very subtile body, and is thus easily and freely reflected every way, without being hindered in its motion ; is it not probable that a considerable quantity of the rays of *Light* which are emitted from the *Sun*, are reflected back again from the earth and other planets, and celestial bodies, with the same ease and freedom to the *Sun* again ? And with much less loss or consumption of *Light* in this, than there would be of *Fire* in the other hypothesis ?

And as it appears from what is said before, that though *Light* and *Fire* are both very subtile bodies, yet as they are two very different beings, and differ so very much in their properties, natures, motions, and actions, and in all the effects which they produce, that they are two different bodies which move and act by different laws of motion.

Fire then is a being which is different in all its properties from all other species of matter that we are yet acquainted with : And is a body which moves and acts by, and is subjected to certain laws of motion, which are peculiar to itself only, and not to any other sort of matter yet known. And that this *Fire* when it is acted upon and put in motion by the motion and attrition of all other bodies ; or by its own repulsive power ; or by the action of *Light* emitted from the *Sun*, does move and act with great power and force, and thereby produces many extraordinary and wonderful effects : All which, when they are carefully examined by suitable methods, and proper instruments and experiments, may be clearly explained, and rationally accounted for, by the preceding propositions, which I have presumed to call the *Laws of motion of Fire*. As it appears from all, the experi-

ments which have been yet made upon it, to be a body which invariably moves and acts, and produces all its extraordinary effects by and agreeably to them, how uncommon and wonderful, or new soever they may appear to be : For though these *laws of Fire* may appear to be new to us, yet they certainly are as ancient as the existence of *Fire*.

I am very sensible that many of the extraordinary appearances, and wonderful phænomena and effects, which *Fire* frequently produces, are very difficult to be explained : Yet I am as well satisfied, that all, even its most mysterious subtile and difficult modes of action and motion, may be fully explained and clearly demonstrated and accounted for by the before-mentioned *laws of motion of Fire*, if our senses are but properly assisted by suitable instruments, and judiciously directed experiments, to set the mysterious modes of motion and action of *Fire* in a clear and proper light.

But as this requires more leisure and application than the avocations of my profession will permit, I was willing to offer these few productions of my labour, with all their defects and imperfections, as they are, to the public, rather than commit them to the flames of the fire ; since it is possible that they may be of some service towards the further improvement of natural knowledge. Wherefore with that view, I shall here subjoin a few *Queries* relating to the same subject, that those who may have more leisure, better opportunities, or greater abilities, may further pursue, examine, and enquire into, and demonstrate and answer them, in order to the further advancement of science.

Some

Some QUERIES,

Several of which yet remain doubtful, and want to be proved and demonstrated by EXPERIMENTS; which being so proved and answered, may both confirm the Truth of the preceding DOCTRINE on FIRE, and contribute many Things towards the Improvement of natural Knowledge, and the Advancement of Science.

Query I. *IS pure Fire a more subtile being than Light? Or the contrary, Light a more subtile being than Fire?*

Q. II. *Does not Light move with greater velocity than the most pure Fire?*

Q. III. *Is the Light which is emitted from the Sun, reflected back again from the planets and other bodies, to the Sun?*

Does not the experiment on the many reflected rays of light, crossing and passing by or through each other every way, without obstructing, retarding, or impeding each other in their progressive motion, as at p. 34. render this very probable?

Q. IV. Do not the elementary particles of the Fire, and the elementary particles of Light act and react upon each other? Or do the particles of Light only repel the particles of the Fire, (the latter being passive,) and put them in motion in parallel right-lines, and cause them to act with force?

Does not the experiment made with the catoptrical speculum, as at p. 11. wherein the fire is driven in right-lines to the speculum by the light, and from thence into its focus, with great force, seem to confirm the latter? And when the light from the Sun extinguishes a common fire, which is exposed to it, by causing the particles of the fire to pass on from it in right-lines, into the adjacent bodies, earth, and air, also confirm the same?

Q. V. Are not colours produced by the action, and reaction, the reflection, and refraction of the particles of the Light, on the particles of the Fire?

Q. VI. And are not those fringed colours, (observed by Sir I. Newton,) produced by that refraction and reflection of the particles of the Light, on the particles of the Fire?

Q. VII. Or do those fringed colours arise from the unequal or quicker motion and more free passage of the particles of the Light through the prisme, than the particles of the Fire, whereby they are more or less refracted and reflected, than the particles of the Fire are?

Q. VIII. Is not this pure elementary Fire, the Æther, or subtle Fluid which pervades all things of Sir Isaac Newton.

As

As it does not appear to any of our senses, neither do any experiments make it appear to them, that there are any other bodies existing in our atmosphere, or within the reach of our knowledge, but air, light, this fire or æther, water, the magnetic effluvia, and such small bodies as are exhaled from the earth, and are floating a little height in the air; we must conclude that there are no other bodies, or mediums. For as to that *circumambient medium*, which Messrs. *Le Cat*, *Calden*, and some *others* have supposed, seems to be only a hypothetical imaginary being, without any demonstration or proof of its existence. And as we are not conscious of the existence of any other bodies or beings in our atmosphere, but those above-mentioned, it is too unphilosophical to admit of any such being, without any evidence, demonstration, or perception of its existence.

Q. IX. What is the reason or cause why the Light emitted from the Sun to the Moon, and from it is reflected to the Earth, has lost its power of acting upon the præ-existing Fire, and putting it in motion in right-lines, and causing it to move with great velocity and force?

It has been demonstrated before, p. 54. that light has this power when it is emitted from the sun: And that it has lost, and has not this power when it is reflected from the moon, p. 63. Yet it still remains to be light, and to shine as light, and to pass on with great velocity in right-lines, but can give no motion to the præ-existing fire, or excite the least sensation of heat, not even to the easiest moved thermometer.

Has the light lost that power by being so reflected? Or does it arise from the diminution of the number of the rays of light, by their diverging, and being scattered by the spheroidal figure of the moon? This last does not seem probable, when we consider that the rays of light are reflected from every point of the surface of the full moon, whose diameter is said to be 2175 miles, to the surface of *Villet's* speculum, whose diameter is but 43 inches, as every part of the face of the moon is seen in the speculum; and consequently those rays should seem to converge in proportion to the different magnitudes, and their distance, since every part of the face of the moon is seen in the speculum; though no doubt but that an immense number of rays of light are scattered by the spheroidal figure of the moon; but as those rays of light are reflected, and converge again into the focus of that speculum, whose diameter is but half an inch, where a most refulgent light is seen, (little inferiour to that which is received from the sun, upon the same speculum, and reflected into its focus,) yet no encrease of heat, or fire, is perceived there. Therefore the difference between the number of the scattered rays by the spheroidal figure of the moon; and the number of the converging rays from every point of the face of the moon to that focus, should be calculated, as near as we can; (though it may be impossible to know exactly what the number of either are, especially the latter,) that we may more reasonably guess whether it is from hence that the light has lost its power of acting upon the fire, and putting it in motion? Or from its having lost that power by acting on the fire in the moon before? Or from what other cause does it proceed?

Q. X.

Q. X. Is the Light which is emitted from the Sun, a different Light from that which is emitted from Fire? And wherein do they differ?

Though light and fire have some properties which are common to them both, as shining and giving light, &c. yet they have others, wherein they differ greatly; as the one is always producing some degree of heat, but the other not producing it; also in the colour of their light, and in some other particular properties, which should be enquired into.

Q. XI. Is not Flame and its Light produced by the action of the particles of the Fire, on the particles of the pabulum, and the reaction of these upon those; by which the particles of the Fire are put in motion in right-lines, and thereby become visible, or give Light?

Q. XII. And are not the constituent particles of the pabulum so minutely rarified, expanded, and divided, by the action of the Fire on them, that they become specifically lighter than the air, therefore, they ascend and carry the particles of the Fire which are in action with them upwards, (as Fire has no gravity) to a certain height, till the Fire passes off by its repulsive power in right-lines, and so produces flame and Light?

Q. XIII. And as the action of the Fire on the particles of the pabulum, and the reaction of these upon those are the greatest in the axis of the flame, are not the particles of the Fire retained the longest by that attrition in the axis of the flame, whilst those

which are the nearest to the surface of it, continually pass off by their repulsive power to their state of rest; and is not this the reason or cause why all flames assume the figure of a cone?

Q. XIV. Is not lightening produced from a much greater quantity of Fire being collected into one cloud, either by its motion, or by the directing power of light from the Sun, and retained by the water in it; and a much less quantity of Fire into another cloud, or into that part of the earth below it, which causes the repulsive power of Fire to exert itself, and restore the Fire to its state of equilibrium again, with great velocity and force? And does not the fire become visible by moving in right-lines from one cloud to the other, or to the earth?

Q. XV. And when the Fire is thus in motion, does it not ignite the sulphurous exhalations which are floating in the air, and so cause or encrease the flash, which exhalations it did not act upon, whilst it was in its still state?

Does not the sulphurous smell which is often perceived after a stroke of lightening, and also after the stroke of fire from an electrical machine confirm this; and is not the flash of lightening rendered visible obliquely, or much encreased by the ignition of those sulphurous particles which are floating in the air at that time?

Q. XVI. Are not Comets great bodies, which were ordained by the great Author of Nature, to carry Fire from one part of infinite space to another, in order to restore and preserve the equilibrium of Fire? Which otherwise might, in process of time, be changed or destroyed

stroyed, by the great and rapid motions, and continual collection of such great quantities of Fire, by the many great celestial bodies in such a continual swift motion?

That all bodies in motion do collect fire in proportion to their quantity of motion and attrition, has been demonstrated before Law I. p. 30. and that all the planets, and probably most of the other celestial bodies, do move with great velocity, is certain; and, therefore must continually collect very great quantities of fire; which probably, in process of time might become so great as to over-balance and overcome the repulsive power of fire, (especially where the motion is so great and continual, and the distance to which the fire is to be repulsed, is so great also,) that it might in process of time, overcome and impare, or destroy the equilibrium of fire, if *infinite Wisdom* had not ordained such bodies as comets are, to carry fire to such immense distances and places, where there is the least quantity of fire; and thereby restore and preserve the equilibrium of fire.

For as the revolution of the great comet, seen in the year 1680, is supposed to be performed in the space of near 575 years, it must pass to an immense distance in that long time, as all comets move with so great a velocity and rapidity, especially when they approach their perihelions, and consequently must collect a prodigious great quantity of fire, as they appear to us to do; and carry it from one part of space to another, to an immense distance, and dissipate and disperse that fire so collected, when they come to the intermediate spaces, or their aphelions, where their motions
are

are the slowest, and consequently the repulsive power of fire will exceed the collective power, by their slower motion the most there, therefore they must disperse and distribute the most fire there; and as few or no bodies exist or move in those spaces, there will be the least quantity of fire in them, and consequently the repulsive power of fire will be the strongest, and the most fire will be dispersed in them, in order to restore the equilibrium of fire. At least, this hypothesis, for so I must but call it, seems to be more rational, and more probable, and likely to be true, than any hypothesis that I have yet seen, relating to the use and office of comets.

Q. XVII. *Are not what are usually called electric attraction and repulsion, solely produced by the motion and action of Fire according to its laws, without any real attraction or repulsion existing between the electrical bodies, and those light bodies which are thought to be attracted and repelled by them?*

Are not the constituent particles of the amber, or glass globe, or tube, put into a strong vibrating motion by the friction of them; and does not that vibrating motion and attrition, attract and collect the fire out of the circumambient air to those bodies? And does not the fire, though invisible, carry such light bodies as are floating in the air with it, to the amber or glass, so long as that vibrating motion continues? See Law I. And when that motion ceases, does not the fire by its repulsive power, Law II. recede, or is repelled from the amber or glass into the air, to its state of equilibrium and rest again, and so carry those light bodies with it back again into the air? Which action is usually called the repulsion of electric bodies,

as

as the former is called the attraction of electric bodies? And are not both these performed solely by the motion of the fire, without any real attraction or repulsion existing between the amber or glass, and those light bodies?

For it is evident that neither amber nor glass, will either attract or repel those light bodies when in a still state, and without that previous friction and attrition, which puts their elementary particles in motion, and that motion and attrition collects the fire, and it carries those light bodies with it to, and from them again.

Q. XVIII. Are not all the electrical experiments which have been yet made, only so many experiments made on pure elementary Fire and its laws of motion? And will not these laws of motion of Fire, clearly and fully account for all the phenomena and effects of all the electrical experiments which have been yet made?

Though these electrical experiments have not been generally thought to be experiments made upon fire, or at least, but so by very few persons, if any; yet I have all along esteemed them as such, ever since they have been so much in vogue; and it appears very clearly to me, that they are so; and I question not, but that they will as clearly appear to be so, to all others, who duly examine, and properly apply them. And also that we may rationally, clearly, and satisfactorily account for, and explain all the appearances and effects, which are produced by electrical experiments, from and by the *Laws of Motion of Fire*.

Q. XIX. Is not there a mutual attraction between Fire and metallic bodies; and also between Fire and Water?

Water? Though the two last are commonly thought to be opposites or antagonists to each other.

Fire being detained by the metallic coating on the inside of a glass receiver, for some time; and its being attracted by the small points of metallic rods, and its being so easily and quickly conveyed from place to place, without being dissipated or scattered, by metallic wires, seem to confirm this.

Also fire being retained in the clouds which are water only, in a considerable quantity before thunder and lightening; and its being conducted by wet-lines, and by water in rivers; and its being retained for a considerable time in water when hot, seem to induce us to believe that it is. But some further experiments are wanting to demonstrate this more clearly; and whether the attraction is in the fire, or in the metals and the water, or mutually in them both, and how it acts.

Q. XX. Is not magnetic attraction caused and performed by the motion and action of this pure elementary Fire or Æther?

Knives and pieces of iron, acquiring a magnetic virtue, or the power of attracting iron, by being struck with lightening, which is this fire, and their retaining that magnetic power for a long time after, as observed in the Philosophical Transactions abridged, vol. 8. p. 505. and p. 742. and Van Lewenhoo's observation, that iron by being placed in a north and south position for a long time upon the steeple of the church at *Delft* in *Holland*, had acquired a strong magnetic virtue by it, as if it had been touched with a strong load-stone.

Though

Though it is possible that it might have been struck with lightening in that time-. And the artificial magnets invented and made by the ingenious Dr. *Gawen Knight*; to which we may add, the great quantity of this fire, which is continually collected at the equator by the motion of the globe, as at p. 46. and its being as continually repulsed from thence towards the poles, seem to countenance this supposition, but more observations and experiments are necessary to confirm and demonstrate this to be true, before it be received as a truth.

Q. XXI. Is not the quantity of Fire collected by bodies in motion in any given space, as the quantity of motion and attrition directly? Or is it as the squares of the quantity of motion and attrition in that space?

From those few observations and experiments, as well as computations which I have made, it seems to be as the quantity of motion and attrition directly. But this should be clearly demonstrated and certainly known; as no doubt but it may: Then many curious questions, both relating to the motions of the planets, and their different degrees of heat and coldness, &c. But also relating to the motion of other bodies, and their degrees of warmth, heat, and coldness, might be more certainly solved.

Can this be certainly known, by the motion of two iron plates one upon the other, as before, Law I. by being moved with different velocities at different times, and the application of accurate thermometers at those times? Or by the motion of any other bodies, and the use of thermometers or pyrometers, applied at equal distant times, so
as

as to measure the encrease of the quantity of heat or fire, as the quantity of motion and attrition in those bodies is encreased? Or if an experiment was made in the farthest northern parts of the earth to which Europeans sail, as at Spitsbergen, with an accurate thermometer, and with a concave speculum, and a pyrometer placed in its focus, at the same time, and for a certain given time, and exactly observe how the mercury rises, and the pyrometer extends; and repeat the same experiments every five degrees, as they return southwards; may not the quantity of fire collected by the motion of the earth at each of those distances from the pole be measured, and then be compared with each other, and again with the quantity arising from a calculation of the quantity of motion of the surface of the earth at each of those distances; so as to find exactly the quantity of fire collected by bodies in motion, and whether it is not as the quantity of motion and attrition directly.

Q. XXII. Is not that great heat which is always found between the Tropics, solely caused and produced by the great quantity of motion and attrition of the earth, against the circumambient air or atmosphere, by which such a great quantity of Fire is collected there? And is not the so much less quantity of motion and attrition, at and near to the poles, the cause why so little Fire is collected near to them, or why it is so cold at the poles?

That it is so, is demonstrated before Corol. III. p. 46. From which computation, it appears, that 44 times as much fire will be collected at the equator, by the motion and attrition of the surface
of

of the earth, against the circumambient air or atmosphere, as there will be collected by its motion at one degree from the pole; and is so much fire or heat, as will cause *Fahrenheit's* thermometer to rise to 86 or 88 degrees at the equator; when at one degree from the pole, the quantity of fire collected there will be so small, and the coldness so great, as to cause the mercury in the same thermometer to descend as low as 2 degrees, or to 0, and so they are both found to be by observation.

Yet it is observed, that a much greater quantity of light is emitted from the sun to the pole in the summer season, as the sun is then always above the horizon, than there is emitted from the sun to the equator; though it is always so much warmer at the equator, than it is at the poles. Consequently, if that light which is emitted from the sun, was real fire, as is generally supposed, it would be warmer at the poles in the summer, than it is at the equator, which is contrary to all observations and fact. Consequently it proves that fire is not emitted from the sun, but light only, which is not fire, but a very different body.

Q. XXIII. *As Jupiter is so large a body, and revolves on its axis in so short a space of time; does not that rapid motion collect such a great quantity of Fire, as to cause it to be as warm in Jupiter, as it is on our earth; notwithstanding his great distance from the sun, through which space the Light from the Sun has to pass to act on the Fire in him.*

As the diameter of Jupiter is said to be to that of the earth, as 1077, is to 104, viz. equal to $82504\frac{1}{4}$ English miles, and his circumference $259298\frac{2}{7}$ miles: And as he is found to revolve
on

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on his axis, once in 9 hours and 56 minutes, but for brevities sake, we shall here take the even number of ten hours.

*The surface
of 1/10 hours*

Then every point on the surface of Jupiter, near the equator, must pass through the space of 259298 $\frac{3}{4}$ miles in every ten hours; but as spheres in motion do not pass on in right-lines, but describe a cycloid in each revolution; so every point on the surface of Jupiter, will describe a cycloid in each revolution; and the length of every cycloid is four times that of the diameter of its generating circle: And as the diameter of Jupiter's circle is computed to be 82504 $\frac{43}{100}$ miles; consequently every point of the surface of Jupiter, near his equator, must move through the space of 330017 $\frac{62}{100}$ miles in every ten hours; or, 33001 $\frac{7}{10}$ miles in each hour, which is near 550 miles in every minute; and is a little more than 25 times swifter than the motion of the earth. How prodigiously great and rapid is this motion of Jupiter's surface! Even more than 91 $\frac{1}{2}$ times swifter than the motion of a ball fired from the largest cannon, which is found to move only 600 feet in a second of time, which is but little more than 6 miles in a minute; whereas Jupiter's surface moves 550 miles in every minute! This exceeding great and rapid motion of Jupiter, must produce a very great attrition, between his surface, and the air of his atmosphere; and consequently must collect a very great quantity of fire every moment of time. *The motion Surface*

And as the velocity of Jupiter's motion, is to the motion of the earth, as 550 is to 22; or as 25 to 1: And as the learned and ingenious Dr. Halley, has computed that the heat of the sun in Jupiter, (supposing that all heat, or fire, is emitted

ted and sent from the sun,) is but one twenty-fifth part of what is on the earth; but as the surface of Jupiter moves twenty-five times swifter than that of the earth, and consequently collects twenty-five times as much fire; if we suppose, that the quantity of fire collected by bodies in motion, is as the quantity of motion and attrition directly, as it appears to be; then the quantity of fire collected by Jupiter, will make it as warm on Jupiter, as it is on this earth; though the light emitted from the sun to Jupiter, to act on the fire in him, may be so much longer in passing to, and so much less in quantity on him, as to act but with one 25th part of the force on the fire on Jupiter, as it does on the earth, yet it will be equally as warm on Jupiter, as it is on this earth.

But if it be supposed that the quantity of fire collected by bodies in motion is as the squares of the quantity of motion and attrition, then the quantity of fire collected by the motion of Jupiter will greatly exceed the heat on earth, and render Jupiter much too hot for such beings as we are, to live in; rather than too cold to be inhabited by such beings as we are, as the learned Drs. *Gregory* and *Halley*, and some other great astronomers have supposed. Is it not therefore much more probable and reasonable to suppose that the quantity of fire collected by bodies in motion, is as the quantity of motion and attrition directly? And if so, then Jupiter is equally as warm, and as inhabitable, as the earth is; and probably more agreeable and pleasant, as all nights there are moonlight, as he has four moons, though the days and nights are but each about 5 hours long.

Q. XXIV. Is not the greatest quantity of Fire collected, and retained in those spaces, where there is the greatest quantity of motion and attrition, and the greatest condensation of the Fire conjunctly?

Q. XXV. And is there not the least quantity of Fire existing, where the least motion, and the most light, and rare bodies only are; or, where the most perfect vacuum is, and consequently no motion?

It appears from many experiments, that these are both true; at least so far as the collection of fire depends upon motion.

As we observe that fire, when it is collected in so great a quantity, into the focus of *Villet's* speculum; it instantly escapes out of that focus, by its own repulsive power, the moment that its supply is cut off: But when it is collected into an iron or brass sphere, either from the same focal fire, or from any other or common fire, that it is retained in them for a considerable time after its supply is cut off, and removed from it.

Q. XXVI. What is the cause why the Fire is thus retained so long in such solid bodies, through which it can so freely and swiftly pass, as we see it does through wires made of those metals? Yet instantly escapes from the above-mentioned focus, where no other body is present?

Is it the corporeal mass of the iron or brass, that retains the fire in them, as there is no other body or being, but them and fire in that space, which they fill? Or is it not rather the vibrating motion of their constituent particles against the elementary particles of the fire, and their action and reaction upon

upon each other, which both collects and retains the fire in those bodies so long? For we see that fire will not retain fire, either in them, or in that focus, or in any other space; but on the contrary disperses itself instantly by its repulsive power.

Q. XXVII. Does body then as matter, attract and retain the particles of the Fire? Or is it the vibrating motion and attrition between the particles of the Fire, and the particles of the iron or brass, which being first put in motion by the penetration of the fire, that motion afterwards attracts and retains the Fire in them, for so long a time, as it continues there? And is it not from hence, that those bodies, which are the most dense, hard, and elastic, collect the most Fire, and retain it the longest in themselves? Whilst those bodies, which are the most light and rare, and the least elastic, suffer the Fire to escape the soonest out of them, by its repulsive power?

It appears from various experiments, that it is not matter, as body or matter, that either attracts, or retains the fire, but as matter put in motion, which both attracts and retains it. For bodies at rest, neither repel, attract, nor retain any fire, more than is in an equal space in the circumambient air. Take three spheres of the same diameter and magnitude, one of solid iron, another of heavy hard wood, the third of soft light wood, immerge them all in the same boiling hot water, till they and the water are all of the same heat, or boiling hot; and you will find that the ball of soft wood, will be the soonest boiling hot; the hard wood the next, and the iron the last of all. Take them out of the water, and expose them all in the same cool air, till they and the air in which

they are suspended, are all equally cold; and you will find again, that the lightest sphere will cool much the soonest, the heavy wood the next, and the iron sphere will retain the heat or fire a considerable time after them both.

Hence it appears, that the more dense, and hard that bodies are, the longer time they require to be made equally hot with bodies that are more rare, when they are both equally exposed to the same degrees of heat: And when they are heated alike, they require so much the longer time to be reduced to the same degree of coldness with rarer bodies. Consequently, the times of receiving, and the quantity of fire received, and the time of its being repulsed and emitted out again, till it is restored to its state of equilibrium, will be as the quantity of matter contained in bodies of the same magnitude. But when it disperses itself, by its own repulsive and penetrating power, it will be distributed through all bodies, and all space equally alike, (if not hindered by some other of its laws,) but the times of its doing it, will be as the quantities of matter in bodies.

Q. XXVIII. *Does not the action of air, by its great elasticity and expansion by Fire, more encrease the action of Fire, by encreasing the motion and attrition between the particles of the Fire, and the particles of its pabulum, or other bodies ignited, as also of the air, than it does by its weight or gravitation, though part by both?*

This appears to be true from several experiments: As by the fire not acting on various sorts of pabulum, and causing them to burn in vacuo, but dissipating and dispersing itself equally through its pabulum, and all other bodies, every way by
its

its repulsive power; but when the air is freely admitted, or directed to the fire with force, as from a pair of bellows, &c. It acts upon the fire, and causes it to move with force, and the fire rarefying and expanding the elastic particles of the air, causes them to act with greater force upon the fire; and this action and reaction upon each other, greatly encreases the motion and attrition between them, and on the pabulum also, and both collects more fire, and causes it to act with greater power and force.

Hence it is, that a strong blast of air from a pair of large bellows, so much encreases the action of fire, and causes it to melt and flux the hardest metals. And hence it is, that a piece of solid iron being heated in the fire red-hot, then taken out of the fire, and instantly placed before the mouth of a pair of large bellows, and the cold air sent from them, upon the hot iron, with a strong blast, without any addition of more fire; (but what that encreased motion and attrition collects,) soon causes that hot iron to melt, and that solely by the encreased motion and attrition, excited by the action of the cold air upon the fire.

Q. XXIX. Is not the quantity of fire received and retained in bodies heated, as their densities, their elasticity, and the quantity of motion and attrition of their elementary particles, with the elementary particles of the Fire, conjunctly?

All the experiments that I have yet made, confirm this, so far as they have been carried, in respect to solid bodies. But there are certain experiments which contradict this, with respect to some different fluid bodies; in which there seems to be some

some very abstruse, and yet hidden cause, why fire is not able to heat some fluid bodies beyond a certain degree. For we know from experience, that no fluid can be made to retain more fire in its body, than will make it boil briskly, let its density be what it will: Yet we find that fluids do not retain fire in their bodies, in proportion to their densities; for water can be made no hotter than 213 degrees in *Fabrenheit's* scale, because it then boils, and emits by that ebullition as much fire, after that, as it takes into itself; but linseed oil, which is lighter than water, will retain so much fire, as will heat it to 600 degrees in the same scale, before it boils, and then can be made no hotter; and yet Mercury, which is 15 times denser or heavier than that oil, can be heated no hotter than 600 degrees before it boils, and then can be made no hotter, because after that it emits as much fire, by the ebullition, as it takes in.

Q. XXX. *What is the cause why water, which is heavier than linseed oil, retains so much less Fire than it? And why linseed oil retains as much Fire as Mercury, which is 15 times denser or heavier than oil.*

Can this extraordinary phenomenon possibly proceed from the great viscosity and tenacity of that oil; or is it from the different degrees of attraction of the elements of these different fluids? And do not the particles of the mercury attract each other, as strongly as the particles of the oil do? Or is there a stronger attraction between fire and such bodies, as are the pabulum of fire, than there is between those which are not? Yet we see that water attracts and retains fire. The true cause of these is undiscovered.

Though

Though fire may be thus added, and conjoined to bodies by art; yet, when nature distributes fire through bodies, *i. e.* when it disperses itself by its own repulsive penetrating power through bodies, it is not in proportion to the quantity of matter, or density of bodies, but in an equal manner in the same quantity through all bodies, whether dense or rare, and through all space, whether empty or full; so that they are all equally warm, or cold.

Q. XXXI. Is the expansive power, or repulsive force of Fire, encreased in proportion to the number of rays or particles of Fire collected? Or in proportion to the smallness of the area of the spaces into which it is condensed? Or by both?

If we could certainly determine how much the force of fire, depends upon the number of its rays, or quantity of its elementary particles; and how much upon the condensation of its elements, so as to be able to know exactly how much the expansive power of fire is encreased, in proportion to the smallness of the spaces into which it is condensed; we should know a great deal more of the nature, power, and force of the action of fire, than we do yet. If it be as the area themselves, then its force will be four times greater on the account of its quantity, and four times on the account of its condensation and expansive force, which is sixteen times greater or more violent from both these causes acting conjunctly. This is therefore much desired to be discovered and exactly known.

It appears from various experiments, that this expansive power of fire, in respect to its density and number of rays, is very great: As, when this fire is put in motion in parallel rays, by the directing

recting power of light from the sun; and they are received upon, and reflected from *Viller's* speculum into its focus, where the number of its rays are greatly multiplied, encreased and condensed, with what prodigious great power and force it acts and destroys all bodies that are put there; and with what force and velocity it expands and restores itself from that focus, to its natural state of equilibrium and rest again, the instant that the parallel irradiation of the sun ceases to act on it.

And we see, that the expansive power of fire, in respect to its condensation and density, is also very great; by the explosion of gun-powder, what great hard solid rocks it breaks and splits into pieces; and what large heavy castles and walls it blows up; and with what prodigious force and velocity, it sends a heavy iron ball to a great distance from a cannon.

Q. XXXII. We want to know how great the velocity of the motion of Fire is? Or, how much time it requires to pass through a given space? Or, how far it passes in a certain given time?

An exact measure of the velocity of the motion of pure fire, is very much wanted, as it is a thing of great importance towards the solution of many curious, useful, and material questions in philosophy.

That fire is a body which moves from place to place, with great velocity, is certain: And that it moves with greater or less degrees of velocity, as it is more simple and pure; or as it is more or less combined with, or joined to some other bodies; or, as it is more or less resisted and retarded by different mediums through which it passes; and

as

as it is more or less condensed into the spaces from whence it is emitted, is very probable.

Let us observe the motion of those meteors, vulgarly called falling stars, which are only sulphurous bodies, collected and ignited in the air; and the fire so joined to that sulphurous pabulum in them, does not move with so great a velocity, as common lightening does: And as the lightening ignites the sulphurous exhalations which are floating in the air, as it passes it seems to move with somewhat less velocity than the pure fire, which is discharged from an electrical machine; and this again probably moves with somewhat less velocity, than the pure fire, which is propelled by light, or that fire, which is restoring itself from the condensed focus of *Villet's* speculum, to its state of equilibrium and rest again.

That ingenious experiment, which was made by several of the worthy members of the honourable Royal Society, in order to measure the velocity of the motion of fire, by extending one piece of wire four miles, and another one mile, merits much applause; though it did not succeed according to expectation; because they found the velocity of the motion of fire to be so exceeding great, that neither the human mind, nor instruments made use of, could divide time so minutely, as to measure its velocity: Though even that motion of the fire was probably very considerably retarded and abated, by its passing through such a dense body as the wire is, to so great a distance.

Would it succeed any better, if one wire could be carried on in a circular, or often returning figure, to the length of one hundred miles, and another half, or a quarter of a mile? Or is its velocity so great, that the human mind, assisted

by the best instruments, is not able to divide time so minutely, as to be able to distinguish and measure its velocity, even in that great difference of 200, or 400 to 1? Or can any other method be found to measure its velocity?

The great Sir *Isaac Newton*, and the ingenious *Reaumur*, have measured the velocity of the motion of *Light*, which is as subtile a body, and probably moves with as great, if not a greater velocity than fire; therefore, it is hoped, that a method will be found out, by which the velocity of the motion of *Fire*, may be measured also.

20 JY 64

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- 71. *ult.* *for* p. 34. *read* 68.
- 72. 4. *for* beioq, *read* being.
- 8. *for* 11. *read* 40, 53.
- 75. 7. *for* is, *read* in.
- 84. 6. *read* the Surface of Spheres.
- 23. *dele* move.
- 32. *read* as the Velocity of the motion of Jupiter's
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